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Offshore pipeline failures.

Woodson, Ross D.

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Offshore Pipeline Failures

by

Ross D. Woodson

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Professor R. G. Bea, Advisor

Hydraulic and Coastal Engineering
Department of Civil Engineering
University of California
Berkeley, California

ABSTRACT

An overview of current concerns in the regulation of offshore pipelines is presented along with tabulated summaries of pipeline failure causes, failure prevention techniques, and pipeline monitoring and early intervention techniques. A database of over 1000 offshore pipeline failures in the Gulf of Mexico Offshore waters has been compiled from combined records of the Department of Transportation Office of Pipeline Safety, U.S. Coast Guard National Response Center, and the Department of Interior Minerals Management Service. The data has been analyzed to identify trends and initial recommendations for future data collection have been suggested.

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I. OBJECTIVES

The objectives of this research were to:

1. Characterize current concerns about pipeline structural integrity assessment and regulation.

2. Introduce a matrix summarizing pipeline failure mechanisms, the controlling factors for each mechanism, methods used to prevent damage, and methods used to mitigate damage or provide early detection/intervention.

3. Introduce an outline of current internal inspection technologies, pipeline surveying technologies, and pipeline monitoring systems.

4. Develop a first generation "user-friendly" public database on personal computer software of marine pipeline failures in the Gulf of Mexico Outer Continental Shelf Area compiled from combined data from the Department of Transportation Office of Pipeline Safety, the U. S. Coast Guard National Response Center, and the Department of Interior Minerals Management Service.

5. Provide an informal, qualitative review of the information on pipeline failures available from the regulating authorities.

6. Provide recommendations for future data collection and organization.

7. Present some initial summaries of trends in pipeline failures versus year of failure, month of failure, nominal diameter of pipeline, age, and burial status.

II. Current Concerns Regarding Offshore Pipeline Regulation

The present (1991) concerns regarding regulation of offshore pipeline structural integrity are as follows:

1. A substantial percentage of the OCS pipeline infrastructure is approaching or operating beyond its design life.

2. Pipeline companies are under high pressure to keep pipelines in service because of high costs of replacement and, in some cases, because of difficulties with the permitting of replacements.

3. The current system of pipeline regulation is not very well coordinated in terms of outlining the specific responsibilities, jurisdictions, and functions of the different agencies. The maintenance of records on existing pipelines is especially in need of improvement.

4. Because of multiple jurisdiction and because trunk lines are often used by multiple operators, it is sometimes difficult to determine who is using a particular pipeline and who has jurisdictional authority.

5. Existing federal safety regulations for gas and liquids transmission pipelines require hydrostatic testing of pipeline segments before initial operation and after relocation, however, pipeline operators are not required to retest pipelines after they are in operation.(U.S. DOT 1983 Sections 192.503 and 195.302) Legislation has been proposed in Congress to mandate the use of internal inspection devices (intelligent pigs) but currently federal regulations are silent on this issue.

6. After several recent fatal accidents in which fishing vessels have struck exposed pipelines, Public Law 101-599 (commonly referred to as HR 4888) was passed in November of 1990. This law requires pipeline operators in the Gulf of Mexico to inspect all pipelines between Mean High Water and 15 feet below Mean Low Water to determine if they are exposed and if they pose a hazard to navigation.

III. Tabulated summary of Offshore Pipeline Failure Mechanisms and Strategies for Their Prevention

The following matrix of offshore pipeline failure mechanisms provides an overview of all the different factors which can lead to the failure of an offshore pipeline. This matrix was developed with the intent of providing an efficient introduction to offshore pipeline failure mechanisms for those who are not currently familiar with this subject and to provide a convenient organization of data for those who are already familiar with this subject and wish to expand upon the chart for their own use. The matrix lists the following information for each failure mechanism:

FAILURE MECHANISM/ PROCESS: The force, action, or phenomenon which leads to the failure of an offshore pipeline. With few exceptions, these are the failure mechanisms represented in the offshore pipeline failure database which has been prepared with this report.

FUNCTION OF: This category describes the physical, quantifiable characteristics of the environment that are factors in determining whether or not a failure will occur. These factors are important not only in the design of the pipeline, but also in a retrospective analysis of historical failures. These items should be the focus of any data collection on historical pipeline failures, since they can be used to directly correlate pipeline failure to specific parameters of the environment. More recommendations on this subject will be made in Section VII of this report.

AVOIDANCE TECHNIQUES: This category describes procedures that can be used to prevent failures by the mechanism being described. Methods that can employed on both new and existing pipelines have been listed.

PREDICTION/INSPECTION/EARLY INTERVENTION/ SPILL MITIGATION: This category describes methods that a pipeline operator can employ to manage existing pipelines as part of a well coordinated Inspection/Maintenance/Monitoring/Repair Program. It also lists techniques for mitigating the effect of spills that can be used on new and existing pipelines.

FAILURE MECHANISM	FUNCTION OF:	AVOIDANCE TECHNIQUES	PREDICTION/INSPECTION/ EARLY INTERVENTION / SPILL MITIGATION
ANCHORS			
Anchor 1- workboat anchors drag in storm catching pipeline and causing bending failure	Storm forecasted? Buried or Covered? Last verified depth of cover? Charted? Work coordinated with operator? Anchor size, type, weight? Soil strength?	more accurate surveys of pipeline location; prepositioned embedment anchors for workboats; improved weather forecasting; deep burial or protection near platforms	automatic valves or check valves to reduce the length of pipeline from which a spill occurs; break away couplings; periodic surveys to verify pipeline location and burial
Anchor 2- random merchant vessel in extremis drops anchor as an emergency procedure	Charted? Buried or Covered? Last verified depth of burial? Anchor size, type, weight? Soil strength?	route selection; very deep burial; rock cover; increased pipeline wall thickness; for soft soils and large anchors, the required depth of burial will be beyond the existing capabilities of pipeline burial techniques	automatic valves or check valves to reduce the length of pipeline from which a spill occurs; break away couplings
Anchor 3- random vessels of any type drop anchor on pipeline resulting in localized coating damage and/or local failure of valve or fitting	Charted? Buried or Covered? Last verified depth of burial? Type of weight coating? Type of corrosion coating?	high strength weight coatings; dome type valve protectors; prepositioned anchors for workboats	maintenance of pipeline burial depth(or cover); automatic valves or check valves to reduce the length of pipeline from which a spill occurs

FAILURE MECHANISM	FUNCTION OF:	AVOIDANCE TECHNIQUES	PREDICTION/INSPECTION/ EARLY INTERVENTION / SPILL MITIGATION
TRAWLS/ NETS			
Trawling 1- net or cable fouls in valve or fitting causing local failure	Charted? Buried or Covered? Last verified depth of burial? Valve protectors used?	route selection; burial; pre-fabricated dome type valve protectors; increased coordination with fishermen	maintenance of valve protectors; automatic valves or check valves to reduce the length of pipeline from which a spill occurs; periodic surveys to verify location and burial
Trawling 2- trawl board, shoe or cable strikes pipeline causing an impact load which damages weight coating and/or corrosion protection coating-this may lead to corrosion or a local change in the specific gravity of the pipeline	Charted? Buried or Covered? Last verified depth of burial? Type weight coating? Type corrosion protection coating?	route selection; high strength weight coatings; burial; protective cover(rock cover, mattresses,etc.); increased coordination with fishermen	maintenance of pipeline burial depth or cover; visual inspection of pipeline for damage to coatings; some intelligent pigs have been developed that can detect damage to weight coatings; periodic surveys to verify location and burial
Trawling 3- trawl board, shoe, or cable gets caught on pipeline body causing bending failure	Charted? Buried or Covered? Last verified depth of burial? Diameter? Wall Thickness?	route selection; burial; cover as above; increased coordination with fishermen; improved trawl board designs; increased pipeline wall thickness	break way couplings; automatic valves or check valves to reduce the length of pipeline from which a spill occurs; periodic surveys to verify location and burial

FAILURE MECHANISM	FUNCTION OF:	AVOIDANCE TECHNIQUES	PREDICTION/INSPECTION/ EARLY INTERVENTION / SPILL MITIGATION
WORKBOATS			
Jackup Rig- crushes pipeline while setting down or dragging spuds	Buried or Covered? Last verified depth of cover? Charted? Work coordinated with operator? Soil strength? Bearing force of spud?	very deep pipeline burial(?); pipeline routing to avoid rig setdown locations; accurate surveys of pipeline locations	automatic valves or check valves to reduce the length of pipeline from which a spill occurs; use of pipeline locating devices prior to rig setdown
Jetting sleds- jetting sled involved in burying new pipeline causes failure of existing pipeline		more accurate surveys of existing pipeline locations; route selection	automatic valves or check valves to reduce the length of pipeline from which a spill occurs

FAILURE MECHANISM	FUNCTION OF:	AVOIDANCE TECHNIQUES	PREDICTION/INSPECTION/ EARLY INTERVENTION / SPILL MITIGATION
OTHER EXTERNAL FORCES			
Thermal forces and Internal Pressure- increased internal pressure and temperature of operating pipeline relative to its condition at time of lay place pipeline in compression under which it may buckle in its plane of least resistance	Buried or Covered? Last verified depth of cover? Diameter? Wall thickness Operating temperature and pressure? Soil characteristics?	expansion loops; lateral restraint of pipeline from burial, rock cover, or anchors; increased pipeline wall thickness	maintenance of pipeline burial depth (or cover); monitoring pipeline position with external locating devices or intelligent pigs;
Earthquakes 1- strong ground motions (can lead to liquefacation which is discussed under Geotechnical)	Strength of Earthquake? Buried or Covered? Last verified depth of cover? Soil characterisics?	stresses are greatly reduced if the pipeline is unrestrained at the soil surface; an exposed versus buried pipeline may be preferred	break away couplings; automatic valves or check valves to reduce the length of pipeline from which a spill occurs
Earthquakes 2- pipelines crossing seismically active faults(deep seated tectonic adjustments)	Amount of fault displacement? Buried or Covered? Last verified depth of cover?	route selection; geological surveys	break away couplings; automatic valves or check valves to reduce the length of pipeline from which a spill occurs

FAILURE MECHANISM	FUNCTION OF:	AVOIDANCE TECHNIQUES	PREDICTION/INSPECTION/ EARLY INTERVENTION / SPILL MITIGATION
HYDRODYNAMIC FORCES			
Lift, drag, and inertial forces- hydrodynamic forces overstress pipeline leading to failure	Wave characteristics? Depth of water? Pipeline Diameter? Buried? Last verified depth of burial? Soil strength characteristics?	burial; adjustments in the designed specific weight of the pipeline; cover(rock or mattress); anchors; sandbagging or grouting; increased pipeline wall thickness	maintenance of burial depth(or cover); sandbagging or grouting as required; break away couplings; automatic valves or check valves to reduce the length of pipeline from which a spill occurs
Vortex Shedding- currents flowing past a spanned section of pipeline lead to a periodic shedding of vortices which can excite a resonant dynamic response in the pipeline span	Current velocity? Wave characteristics? Pipeline Diameter? Pipeline specific gravity? Buried or Covered? Last verified burial depth?	burial; adjustments in the designed specific weight of the pipeline; cover(rock or mattress); anchors; sandbagging or grouting; scour prevention(see scour below); vortex spoilers; route selection to avoid rock outcroppings or other areas where spanning may be required	maintenance of burial depth(or cover); sandbagging or grouting as required; monitoring pipeline position for spans using external locating devices or intelligent pigs; automatic valves or check valves to reduce the length of pipeline from which a spill occurs
Wear or abrasion- wave forces cause relative movement between contacting pipelines	Wave characteristics? Flexibility of crossing pipelines?	proper separation of pipelines, especially at crossings; use of rubbing pads;	inspection by divers or ROVs

FAILURE MECHANISM	FUNCTION OF:	AVOIDANCE TECHNIQUES	PREDICTION/INSPECTION/ EARLY INTERVENTION / SPILL MITIGATION
GEOTECHNICAL STATIC			
Diapiric- mudlumps can be encountered especially in deltaic areas where stresses from accumulating sedimentation can cause the clay layer to be foced up at the toe of the sediment slope	soil shear strength; pipeline diameter; bearing capacity factors; depth of pipeline in seabed	route selection; geological surveys;	break away couplings; automatic valves or check valves to reduce the length of pipeline from which a spill occurs; monitoring the build up of sediment in deltaic regions
GEOTECHNICAL / HYDRODYNAMIC			
Scour- localized sediment transport adjacent to pipelines causes spanning resulting in vortice shedding(dynamic loads) and/or increased localized stresses due to the pipelines unsupported weight(static loads)	Buried? Last verified depth of cover?	route selection; geological surveys; burial; cover; artificial seaweed;	monitoring pipeline position for spans using external locating devices or intelligent pigs;
Coastal Erosion- intense waves from winter storms or hurricanes can significantly redistribute sediments nearshore leading to increased wave forces and exposure of pipelines making them susceptible to other damage	Buried? Last verified depth of cover?	route selection; anchors(?); proper choice of specific weight of pipeline; charting possible hazards	pipeline surveys to verify location and depth of cover;

FAILURE MECHANISM	FUNCTION OF:	AVOIDANCE TECHNIQUES	PREDICTION/INSPECTION/ EARLY INTERVENTION / SPILL MITIGATION
GEO / HYDRO (CONT'D)			
Liquefaction/ Remolding- cyclic loadings from waves or earthquakes cause increased soil pore pressures which can liquefy non-cohesive soils and reduce the shear strength of clays by remolding	Buried? Last verified depth of burial?	choose the specific weight of the pipeline so that it approximately equals that of the liquified soils or bury the pipeline beneath the depth where hydrodynamic pressures are deteriorating the soils	monitoring pipeline location and burial
Mudslides, mudflows, turbidity currents- slope failure precipitated by: a. increased stresses due to build up of sediments (creep or sudden failure) b. increased stresses due to decrease in pore pressures from change in water level c. hydrodynamic stresses sue to waves	Slope angle? Soil strength? Soil density? Pipe diameter? Width of failure area? Pipeline orientation to slope? Location of pipeline relative to slope (e.g. top of slope, bottom of slope, etc.)	route selection; geological surveys; if downstream of soil movement, burial is desirable, however, in area of soil movement, stresses will be greatly increased by burial and an exposed pipeline may be preferred; orienting the pipeline so that it runs downslope minimizes the stress on the pipeline; increased pipeline wall thickness	break away couplings; automatic valves or check valves to reduce the length of pipeline from which a spill occurs; monitoring the build up of sediment in deltaic regions
Mud waves-weakened fluid soils at the seafloor act to increase the specific mass of seawater and increase wave forces	Type of soil?; Soil strength?; Water depth?; Wave characteristics?	Burial beneath sediment layer that will undergo oscillations	monitoring pipeline location and burial

FAILURE MECHANISM	FUNCTION OF:	AVOIDANCE TECHNIQUES	PREDICTION/INSPECTION/ EARLY INTERVENTION / SPILL MITIGATION
CORROSION			
External corrosion- electrochemical process consisting of the dissolution of metal into solution at the anode and the removal of the resultant free electrons at the cathode in an electrically conductive solution	Water depth? Type of corrosion protection coating? Type of field coating used at joints?	cathodic protection: make the reaction on the pipeline cathodic by impressing a current or by attaching a metal to the pipeline which is anodic(has a higher potential energy than) to steel; separate the steel from the environment: paints and coatings	regular visual inspections of all topside lines; cathodic potential surveys done by divers or ROV's; maintenance of anodes on cathodic protection system
Internal Corrosion- electrochemical process as above set up by the presence of contaminants such as water, hydrogen sulfide(sour corrosion) and carbon dioxide (sweet corrosion)	Details of the prevention program undertaken by the operator	treatment of transported materials: gas drying, proper treatment of well injection water, removal of well injection water, removal of dissolved gases, use of chemical corrosion inhibitors; periodic cleaning of the pipeline; use of inner surface coatings; use of corrosion resistant materials; use of pipeline liners; increased pipeline wall thickness	monitoring and documenting: producing systems: flow rate, water cut, temperature, pressure, gas/water composition, production method, ion concentration, pH, bacteria presence, iron content corrosion control program: inhibitor use, pigging (both cleaning and inspecting);

FAILURE MECHANISM	FUNCTION OF:	AVOIDANCE TECHNIQUES	PREDICTION/INSPECTION/ EARLY INTERVENTION / SPILL MITIGATION
MAINT & OPERATION			
Pigging Accidents- stuck pig	operator	proper use of gauging pigs; proper design of pipeline for pigging	development of pig inspection specifications to assure proper clearances and radii are provided; use of stuck pig retrieval systems
Paraffin plugging-	operator	inhibitors; solvents; dispersants; surfactants; periodic cleaning with pigs; insulation	pigging(cleaning pigs), monitoring flow conditions
Dropped/Discarded Objects on the Sea Floor- object dropped on pipeline or object abandoned on sea floor is dragged across pipeline by currents	operator/ other parties	burial; early removal of object from sea floor; route to avoid areas where objects are likely to be dropped; increased awareness of operating personnel on platforms to avoid dropped objects	maintenance of pipeline burial depth(or cover); automatic valves or check valves to reduce the length of pipeline from which a spill occurs

FAILURE MECHANISM	FUNCTION OF:	AVOIDANCE TECHNIQUES	PREDICTION/INSPECTION/ EARLY INTERVENTION / SPILL MITIGATION
MATERIAL FAILURES			
Weld failures-	weld specifications	proper welding techniques	hydrostatic testing; ultrasonic methods(internal or external)
Flange failures- flange loosens due to axial strain of flange bolts or flange not properly aligned resulting in failure of gasket	flange specifications? location on pipeline?	hydraulic torquing tools; proper fit-up of repair sections	hydrostatic testing; using acoustical pigs to detect small leaks; visual inspections for leaks;
Buckling Propagation- localized failure caused by any of the above listed failure mechanisms is propagated along the length of the pipeline by hydrostatic pressure	buckle arrestors used?	buckle arrestor-an area of pipeline with increased wall thickness which requires energy beyond that provided by hydrostatic pressure to be deformed	ensure use of buckle arrestors; prevent local bending failures; automatic valves or check valves to reduce the length of pipeline from which a spill occurs

IV. A Review of Internal Inspection Techniques (Intelligent Pigs)

The innovation in the area of the internal inspection of pipelines over the last twenty years has been nothing short of amazing. Within the next ten or twenty years it may be possible by running an electronic device (intelligent pig) inside an in-service pipeline to provide a relatively complete analysis of its condition including:

* accurate surveying data, along with indications of spanning
* the condition of its weight coating,
* the location and size of internal and external defects,
* the presence of any leaks,
* the condition of internal coatings and the effectiveness of the corrosion prevention program.

Obviously, large economic incentives exist for further research in this area. A note of interest is that the Battelle Columbus Division in Columbus, Ohio is working under the auspices of the Gas Research Institute to build an independent research center for testing and development in this area. The project was projected to be completed this year and its goal is to work with both pipeline operators and vendors of in-line inspection technology to evaluate existing systems, make improvements, and develop new concepts.

The following matrix of internal inspection tools and techniques provides a survey of proposed and existing technologies in this area. The information has been tabulated after a thorough search of many articles in the literature on this subject. It is difficult to come up with objective data on this subject since many of the reports available are written by the proponents of a specific idea. In some cases, it is difficult to determine from reading the article if the technique is actually available or whether it is in the early stages of development. Where specifications have been listed, they represented an average figure of the claims of several articles.

SYSTEM TYPE	ADVANTAGES	DISADVANTAGES
Intelligent Pigs(General)- inspection tools with on board instrumentation and power which are propelled down the pipeline by pressure acting against flexible cups around the perimeter of the device	Can be used on operating pipelines to provide data on the types and locations of defects; increasingly sophisticated tools and techniques are being developed; less expensive than hydrostatic testing; provides more quantitative and qualitative data than hydrostatic testing	pipeline must have smooth transitions, appropriate valves and fittings, and equipment for the launching and recovery of the pigs; more quantitative data than is currently provided by available tools is still needed; typically limited to operating temperatures less than 75°C ; the amount of equipment that a pig can carry is limited by the diameter of the pipeline
Gauging Tools- the crudest form of this tool consists of pig with circular, deformable metal plates slightly smaller than the pipeline diameter which are bent by any obstructions in the pipeline; mechanical feelers as described below may also be used for this purpose Applications : identifying obstructions caused by dents or buckles in the pipeline	identifies anomalies in the pipeline diameter prior to running less flexible pigs which may become stuck; very inexpensive technique for identifying dents or buckles in a pipeline	does not identify the locations of obstructions
Mechanical Feelers (Caliper Pigs)- analog type device in which mechanical fingers on the pig ride along the inside surface of the pipeline and record changes in inside diameter Applications: Internal corrosion detection, checking pipeline ovality and geometry prior to running more sophisticated pigs	simple, reliable, relatively inexpensive	when used for corrosion monitoring the detection of changes in internal diameter limited to the radial points over which the feelers ride; scale and corrosion products can cover defects thereby preventing their detection; data is typically recorded on paper charts and is therefore difficult to store and manipulate in further analyses

SYSTEM TYPE	ADVANTAGES	DISADVANTAGES
Magnetic Flux- a magnetic flux induced in the pipeline seeks the path of least resistance along the pipeline itself or along an alternate path provided by a series of transducers brushing along the magnetized pipe. In areas where the pipeline walls are affected by corrosion the flux will travel through the transducers in direct proportion to the amount of corrosion in the pipe walls; dents and buckles are also located where the transducers lose contact with the pipeline wall Applications: Internal and external corrosion detection; dent and buckle detection	well established method(first introduced in 1965);performs under the operating conditions of the pipeline; can be used in pipelines as small as 6 inches in diameter; detects circumferential cracks; benchmarks for calibrating the location of instrument records can easily be established by placing permanent magnets on the pipeline at predetermined intervals; girth welds are clearly identified and can further aid in calibrating logs by providing an horizontal reference; relatively insensitive to pipeline cleanliness; can operate at full efficiency at speeds up to approximately 10 mph	will not detect longitudinal cracks(which are typical for stress corrosion cracking); difficult to detect flaws in girth welds; difficult to differentiate internal flaws from external flaws unless used in conjunction with other techniques; there is still a relatively high degree of uncertainty in analyzing the data which may lead the operator to initiate repairs where they are actually not needed and, on the other hand, may fail to identify a significant fault: rigorous computer analysis of the data can significantly reduce this uncertainty and new generation tools with larger numbers of sensors and more sophisticated analyses are doing so; loses effectiveness as pipe wall thickness increases; information gathering may be limited in gas pipelines where the speeds of flows are in excess of the tools capabilities; difficult to monitor corrosion progress because of difficulties in interpreting changes in signals from previous inspections

SYSTEM TYPE	ADVANTAGES	DISADVANTAGES
Ultrasonic (Traditional)- high frequency sound waves are propagated into the walls of the pipeline and a measurement is made of the waves reflected by the internal and external surfaces (pulse-echo concept) Applications: internal and external corrosion detection	provides an accurate, quantitative measurement of the pipe wall thickness; available for pipeline sizes as small as 12" in diameter; effectiveness not limited by pipe wall thickness	cannot detect radial cracks; for optimal performance the wave propagated wave path must be perpendicular to the wall of the pipeline; a liquid must be present in the pipeline as a coupling medium for the propagation of acoustic energy; limited by pipeline cleanliness
Ultrasonic (Non-traditional)- ultrasonic pulses are introduced into the pipe wall through wheel mounted transducers thus eliminating the need for the liquid interface	can be used in gas pipelines since no coupling medium is required	still under development
Eddy Current- a sinusoidal alternating electromagnetic current field is distributed over the pipe wall by an exciter coil. Anomalies in the magnetic properties of the wall caused by corrosion are detected as changes in the current field by detector coils	can detect longitudinal cracking	scans along a spiral path therefore multiple runs are required to detect long cracks; can detect only internal flaws; still under development
Remote Field Eddy Current- same as above except that the sensors detect changes in the current field in an area a short distance from the exciter field called the "remote field" where the voltages are much lower but where signals are received from both the internal and external walls	can detect internal and external flaws	still under development

SYSTEM TYPE	ADVANTAGES	DISADVANTAGES
Gyroscopic Devices measure changes in acceleration and integrate to provide a continuous record of pipeline location Applications: updating surveys for purposes of charting and for back-calculating pipeline stresses and monitoring pipeline movements	potentially a very inexpensive method of surveying pipelines	still under development
Video Devices- carry video cameras in emptied pipelines	self propelled units are available that do not require pig traps to launch; provides visual verification of damage	pipeline must be emptied; results limited by pipeline cleanliness
Acoustical Devices- detect the sound of leaking products	the current state of the art provides for the detection of leaks in liquid pipelines	leaks in gas pipelines cannot be detected with the current state of the art devices
Camera Tools- take flash photographs at set intervals or as triggered by on board sensors; allows examination of the pipeline for visible flaws	good quality photographs can be attained which provide valuable information on internal corrosion and pipeline geometry and ovality, along with some information on girth welds	pipelines must first be cleaned; liquid pipelines must first be emptied
Burial and Coating Inspection- nuclear radiation used to inspect pipeline weight coating and burial	reduces need for external inspection	
Isolation Pigs- grip the pipe wall and provide a seal; controlled by acoustic or electromagnetic signals	can be used in combination to isolate a section of pipeline for inspection or repair	

V. An Overview of Pipeline Surveying Systems

Pipeline surveying is important to provide accurate data on the locations of pipelines for charting, conducting offshore operations in the vicinity of pipelines, identifying pipeline spanning problems, and for back calculating stresses based on changes in the configuration of the pipeline. Especially in shallow waters, pipeline surveying is required to verify that pipelines remain buried in spite of coastal erosion and other changes in the morphology of the seabed. The passage of Public Law 101-599 (commonly referred to as HR 4888) which requires pipeline operators in the Gulf of Mexico to inspect all pipelines between Mean High Water and 15 feet below Mean Low Water to determine if they are exposed and if they pose a hazard to navigation has brought a lot of attention and innovation to this area of pipeline monitoring and maintenance.

In general, the two methods of pipeline surveying are:

Transverse Surveying (*spot surveying*) - instruments are towed across the pipeline at predetermined intervals to fix its location at these points.

Longitudinal Surveying (*continuous surveying*) - instruments are towed over the pipeline along its length to provide continuous fixes

The following table provides a summary of some of the deep and shallow water pipeline surveying methods that are available:

SYSTEM TYPE	ADVANTAGES	DISADVANTAGES
ROV/Sled/Crawler Mounted Systems		
General Capabilities In deep water: ROV is launched by support vessel whose position is tracked by SATNAV or GPS. Position of ROV relative to vessel is detected by a hydroacoustical system In shallow water: Self propelled crawler or sled towed by support vessel. Since hydroacoustic systems do not function well in shallow waters, a crawler will typically be tracked from shore or a platform with line of sight surveying equipment or by a GPS antenna mounted on a mast which extends above the water.	ROV/Sled/Crawler can carry multiple devices while conducting survey(e.g. video, bathymetry measurement instruments, potential survey equipment to monitor the effectiveness of cathodic protection systems, can work in higher currents than divers, can work at deeper depths than divers, economical for long surveys; production rates for ROV average .75^{nm}/hr ; bathymetric data can be acquired by the support vessel during the survey; if necessary a diver can crawl down the ROV umbilical to the pipeline for further inspection or repairs	requires large crew for support, technical support may not be availabe in remote areas, weather sensitive
ROV/Sled/Crawler Locating/Tracking Devices		
Magnetic Gradiometer Array- measures magnetic field near a pipeline and by electronically tuning out the earth's magnetic field can detect the anomoly caused by the pipeline and thus the position of the pipeline	well-established record of use in the North Sea; can be used for transvere or longitudinal surveys; can track 4" line to 10' burial, 16" line to 20' burial, and 48" line to 30' burial	Requires a large crew for support; expensive; weather sensitive
Video- one camera or a series of cameras mounted on a boom to provide different views of a pipeline are used to follow the pipeline	relatively fast and inexpensive; can be used with other devices and taken advantage of to track unburied portions of pipelines and to verify spanning	limited by visibility; does not work for buried pipelines;
Trench Profiling Systems- an acoustical system that provides a cross sectional profile of the pipeline		
Electromagnetic Induction- an electric current field created by sensors near the pipeline is abruptly terminated creating a collapsing magnetic field which sets up currents and an associated magnetic field in the pipeline which is detected by sensors	new	

SYSTEM TYPE	ADVANTAGES	DISADVANTAGES
Towed Devices		
Proton Precession Magnetometer- measures total magnetic field; mounted in "fish"; support vessel tows fish in crisscross search pattern and operator detects change in magnetic field; by crossing the pipeline in opposite directions the pieline location can be averaged for the two directions to give a more accurate fix	can be used in conjunction with other towed devices	can be used only in transverse technique
Side Scan Sonar- acoustic pulses are reflected off the seafloor and the intensity of the reflected signal is interpreted to identify the location of the pipeline	very well established technique; can be used in longitudinal surveying; relatively fast; provides information on the seabed features in the vicinity of the pipeline, e.g. sand waves, mud flows, and abandonned objects	to accurately fix the location of the pipeline, the position and orientation of the fish needs to be known at all times; ROV systems provide more accurate fixes; not very accurate *in* detailing problems with spanning
Sub-Bottom Profiling Sonar- pulses of acoustic energy from a towed seismic source are reflected off the seafloor to a hydrophone and variations in acoustical velocity are interpreted to provide information and soil strata and to locate the pipeline	provides information of soil profiles in the vicinity of the pipeline	can be used only in transverse technique

SYSTEM TYPE	ADVANTAGES	DISADVANTAGES
Diver Surveys		
Diver Surveys (General Capabilities)	cost effective for vey limited surveys	expensive; slow; limited by visibility; diver can carry limited amount of equipment; limited by current;
Acoustical Signal- signal is transmitted down pipeline and detected by diver with handheld receiver	small support crew required; relatively inexpensive	acoustic waves attenuate at cathodic protection anodes limiting the distance over which this technique can be used to around 2,000 ft or so fo a line with normal anode spacing
Probing- divers "walks down" pipeline and probes for pipeline	tried and true	

VI. An Overview of Pipeline external inspection & Monitoring Systems

Besides the internal inspection techniques previously presented, there are many techniques for the external inspection of pipelines. These devices are presented in this section together with techniques for monitoring the pipeline system as a whole.

SYSTEM TYPE	ADVANTAGES	DISADVANTAGES
Externally Applied Devices- Ultrasonic-ultrasonic impulses are propagated into the pipe wall and measurements are made of the reflection off the internal and external walls Gamma Ray and Radiographic (X-Ray) Inspection-rays are radiated at or through the pipe and the unabsorbed radiation is measured and correlated to pipe wall thickness		pipeline must be accessible or made accessible
Tracers- radioactive or otherwise detectable tracers are strategically placed into the pipe wall. If corrosion extends to the thickness at which they are placed, they are released and detected by sensors near the outlet of the pipeline	could conceivably be a relatively inexpensive indication of corrosion at critical areas	has never been used by the industry; would not provide quantifiable information on the location of corrosion unless you could determine which tracer location had corroded; it would be difficult to prepostion tracers since most internal corrosion is very random and localized

SYSTEM TYPE	ADVANTAGES	DISADVANTAGES
Real Time Leak Detection Systems- instruments measure characteristics of the flow (e.g. flow rate, product density,temperature, and pressure) at different points along the pipeline and alert operators to changes	early spill detection can lead to reduced spill quantities; generally speaking, the larger the leak, the faster it can be detected	expensive; must contend with extreme variations (noise) in the measurements; subject to false alarms
Hydrostatic Testing- pipeline is filled with water and pressurized while a gauge is monitored to detect release of pressure indicative of a leak	conventional, well known procedure; provides a definite indication of leaking	very expensive; requires that line be taken out of service; requires large quantities of water which must be treated so as not to introduce microbiological corrosion into the pipeline and which must be thoroughly removed as a safeguard against electrochemical corrosion;does not provide any specific information on the location or type of defect; may further weaken areas of partial damage by overstressing; provides no indication of partial (developping) damage
Aerial Reconnaissance- visual reconnaissance is the most common leak detection method currently used; new techniques for aerial reconnaissance using side scan radars and infrared and ultraviolet cameras are under development	can monitor a great number of pipelines quickly; visual confirmation provides maximum certainty of an actual leak; provides a general location	flying limited by weather; visual techniques limited by rain, fog, and darkness; sea conditions may make a slick difficult to detect

VII. PIPELINE FAILURE DATABASE

A. Benefits of Maintaining Historical Failure Information

1. Provides operators and regulators with a tool to assess the overall effectiveness of their efforts.

2. Provides an indication of trends in failures which may require further investigation.

3. Could be used by pipeline operators and designers to provide statistical data for use in decision making

4. Could provide more information for investigations of failure mechanisms which cannot yet be analytically modelled

B. Objectives of This Database

1. Provide an historical record of pipeline failures that can be used to improve current offshore pipeline design, operation, and maintenance.

2. Demonstrate the value of a database of failures.

3. Indicate the type of failure information currently available through regulating agencies.

4. Identify different sources of pipeline failure data.

5. Highlight areas in current data collection that may be lacking.

6. Provide initial data for a possible study into designing a comprehensive approach to data collection which is coordinated among all pipeline regulating organizations.

7. Present the database in a "user-friendly" status along with sufficient information on its organization so that it can be easily accessed and maintained.

C. Approach Taken in Compiling the Database

1. Every attempt was made to maintain all of the quantitative data fields applicable to a study of offshore pipeline failures that were available from each source of failure reports.

2. An attempt was made to combine information from as many different sources as possible.

3. The source of each failure record was maintained separately so that a comparison of the records maintained by each agency could be made.

4. Some judgement and assumption had to be applied in interpreting incomplete failure reports. This was done only where there was a rather high degree of confidence about what the report was attempting to state.

5. Where multiple reports of the same failure were encountered and there were discrepancies between the reports, the most detailed or the most current account was assumed to be the most accurate.

6. Only reports of leaks from gas, crude, or condensate lines were included in the database. Reports of lube oil leaks, diesel, etc. from offshore production equipment were discarded since this report makes no attempt to address failures on platforms(except for risers).

D. The Organization of the Database

1. After a review of the data collected, a decision was made to compile only the data from the Gulf of Mexico Federal OCS Region. This decision was made for the following reasons:

a. there was not enough time allotted for this report to compile all of the information collected

b. the system of block descriptions and block numbers used in the Gulf of Mexico OCS Region make it easy to recognize this information

c. this represents the bulk of information collected

d. the Gulf of Mexico data has been used in several other studies that can be used for comparison with this study

e. all of the different sources of information had data on the Gulf of Mexico, whereas only one source of information provided significant numbers of data on other areas

2. Data was collected from a total of four different sources. The fact that the organization of the data from each source was different presented some difficulties in structuring a single database. In order to maintain the maximum amount of information from each source and in order to facilitate updating of the database, an approach was chosen whereby a separate database was first compiled for each source and then a master database with all the fields from each of the databases represented was compiled by combining all the individual databases. After the separate databases were combined, a manual screening for duplicates was made to produce a single record with all the information from the different sources.

The master database was named PIPELINE.DBF. A listing of all of the fields contained in this database along with their descriptions is given in Appendix B.

E. Sources of Data

1. Department of Transportation Office of Pipeline Safety (OPS):

a. **Gas Pipelines**-For gas transmission lines and gas gathering systems governed by Title 49 of the Code of Federal Regulations (CFR) Parts 191.5 and 191.15, failures meeting any of the following criteria must be reported to the Department of Transportation on their form RSPA 7100.2(3-84) "Incident Report - Gas Transmission and Gathering Systems":

a)results in death or personal injury requiring hospitalization,

b)results in any segment of a transmission line being taken out of service,

c)causes gas to ignite,

d)results in property or product loss in excess of $50,000 (prior to 1984, the property loss threshold for reporting was $5,000.), or

e)is significant in the judgement of the operator even though it did not meet the specified criteria.

A total of 77 incident reports on offshore gas pipelines from the period 9/9/84-7/7/90 were received from the OPS for this report. The information was provided in the form of copies of

actual reports. The number of reports received for each year were as follows: 1984(6); 1985(14); 1986(6); 1987(11); 1988(11); 1989(19); 1990(10). All but one of the incidents were in the Gulf of Mexico. The one exceptional report was in California. An example of a Gas Transmission and Gathering System Incident Report is shown in Appendix A. The report provides by far the most useful information of any of the data collected, however, the threshold for reporting of $50,000 filters out all but the largest failures. The data from these reports were organized into a separate database named GASLIST.DBF prior to placing them into the combined database. A listing of all of the fields contained in this database along with their descriptions is given in Appendix B.

b. **Liquid Pipelines**- For liquid pipelines governed by Title 49 of the Code of Federal Regulations (CFR) Parts 195.50, failures meeting any of the following criteria must be reported to the Department of Transportation on their form DOT 7000-1 "Accident Report - Hazardous Liquid Pipeline":

a)results in death or bodily harm,
b)results in an explosion or fire not intentionally set by the carrier,
c)results in an escape to the atmosphere of more than 5 barrels a day of highly volatile liquids,
d)results in property damage to a second party of $1,000 or more, or
e)results in property damage to the carrier of $5,000 or more.

A total of 12 accident reports for offshore liquids pipelines from the period 12/20/85-7/26/90 were received from the OPS for this report. This information was also provided in the form of copies of actual reports. The number of reports received for each year were as follows: 1985(1); 1986(2); 1987(1); 1988(3); 1989(4); 1990(3). All but one of the incidents were in the Gulf of Mexico. The exception was in Prudhoe Bay, Alaska.

An example of a Hazardous Liquid Pipeline Accident Report is shown in Appendix A. The report is similar in detail to the Gas Incident Report. The data from these reports were organized into a separate database named LIQLIST.DBF prior to placing them into the combined database. A listing of all of the fields contained in this database along with their descriptions is given in Appendix B.

2. Department of Interior Minerals Management Service Data:

The MMS provided its complete current listing of pipeline failures in the Gulf of Mexico which consists of 826 incidents during the period from 8/27/67 to 10/26/90. This represents by far the largest single source of failure data on the Gulf of Mexico found in the preparation of this report. The data is kept in a typewritten tabular format and apparently has not been placed into a database except by some other researchers doing work in this area. Unfortunately none of these electronic listings were available for this report, so this data was also manually entered into the database. An example page from the data kept by the MMS is included in Appendix A. A second source of MMS information on pipeline failures was provided in OCS Report MMS 88-0011 "Accidents Associated With Oil & Gas Operations-Outer Continental Shelf 1956-1986". The information in this report was compared with that given in the tabular listing of failures and the most complete version of the information was put in the database.

The MMS also provided a printout of its electronic database inventory of pipelines in the Gulf of Mexico OCS Region which provides a segment number along with information on pipeline diameter, age, length, status, burial, and ownership for approximately 19,000 miles of GOM OCS pipelines. An example page of this information is included in Appendix A.

For each failure in the MMS data an attempt was made to manually look up the segment in the pipeline inventory to identify the segment number, the length, the construction date, and the burial code. This information was added to the failure information and compiled into a separate database named RMMSDATA.DBF and then combined into the master database. A listing of all of the fields contained in this database along with their descriptions is given in Appendix B.

3. **U. S. Department of Transportation, U. S. Coast Guard, National Response Center(NRC):**

A request was made to the NRC under the Freedom of Information Act for "all data recorded for all pipeline failures occurring offshore back to 1982"(which was when the NRC began collecting data). The Coast Guard offered the option of delivering this information on magnetic tape or as printed material. Printed material was chosen since the data was to be inputted into a PC versus a main frame computer. The Coast Guard responded with 881 records from the period of January 1982 to October 1991. Of this data 206 reports could be identified as occurring in the Gulf of Mexico OCS Region from the block description and

block numbers used in the description of the location of the accident. This data was the last to be inputted into the master database and it is interesting to note that 154 of these accidents were not included in the data from either the DOT or the MMS. The rest of the data was from the following areas. This information is provided because it gives an indication of the scope of the problem of pipeline failures in internal waters of the United States and it might give some indication of the completeness of the records being received at the NRC. Please note that these figures include all failures regardless of the commodity spilled, much of which is refined products:

Texas: 136 reports, mostly from state waters, bays, and bayous of the Gulf of Mexico
Louisiana: 375 reports, mostly from state waters, bays, and bayous of the Gulf of Mexico
Mississippi: 8 reports, all from bays and bayous of the Gulf of Mexico
Alabama: 1 report from state waters of the Gulf of Mexico
Florida: 4 reports
California: 49 reports (17 of these were crude oil leaks in the Pacific Ocean)
Oregon: 1 report
Washington: 2 reports
Alaska: 1 report
Arkansas: 9 reports
Oklahoma: 6 reports
Tennessee: 1 report
Virginia: 3 reports
Maryland: 1 report
West Virginia: 1 report
New Jersey: 4 reports
Maine: 2 reports
Puerto Rico: 5 reports
Virgin Islands: 4 reports

The NRC data from the Gulf of Mexico was compiled into a separate database named NRCINFO.DBF and then combined into the master database. A listing of all of the fields contained in this database along with their descriptions is given in Appendix B.

4. Failure Data From Literature:

Reports of 46 different pipeline failures were taken from an article written by M.D. Reifel entitled "Storm Related Damage to Pipelines, Gulf of Mexico" which was published in Pipelines in Adverse Environments, ASCE, New York, N.Y. 1978. These records were entered directly into the master database and identified by the number 1 in the REF (reference) field. Information from other sources in the literature on this subject could be readily added in a similar manner.

5. Failure Data From State Agencies:

No information from state agencies were include in the database. The State Lands Commission of California was very helpful in providing a computer printout of 22 failures over the period from November 1980 to August 1989 but this was after a decision had been made to concentrate on Gulf of Mexico OCS information. This data has been saved along with all the other raw information. Representatives of other state agencies (the Texas Railroad Commission and the Louisiana Department of Natural Resources) who were contacted telephonically at the beginning of this project indicated that the information collected by the Department of Transportation OPS was indicative of almost all pipeline failures in their states. From a review of the data received from the NRC, it is apparent that many failures occur which are below the DOT thresholds and therefore are not included in DOT records. Further efforts toward collecting state records might be of interest to help further define the scope of failures in non-federal waters of the Gulf of Mexico.

7. Failure Data From Pipeline Operators:

No information from pipeline operators was collected. A future effort towards collecting such data or, at least, soliciting input on the data collected to date is recommended.

8. Failure Data from Non-Petroleum Related Sources:

No information from non-petroleum related sources (e.g. commercial fishing organizations and environmental protection organizations) was collected. There was no verification that such records exist, however, future attempts at recording facts and opinions from these organizations is recommended.

F. Highlights of the Database

1. The database was compiled on Fox Software, Incorporated's Foxpro Software. The program offers pull-down menus, it is compatible for use with a mouse, and it is relatively easy to learn and use.

2. A total of 1047 records of pipeline failures in the Gulf of Mexico OCS Region from 2/27/67 to 10/9/91 have been compiled.

3. The data is comprised of records from the sources described previously as follows:

> DOT Data: 89 records from 9/9/84 to 7/26/90
> MMS Data: 826 records from 2/27/67 to 10/26/90
> NRC Data: 206 records from 1/11/82 to 10/9/91
> REF1 Data: 43 records from 2/27/67 to 7/5/78

During the 5 $^1/_2$ year period from 1/1/85 to 6/30/90, reports from DOT, MMS, and NRC are all represented. This period, since it is the most well represented, provides the best overall data for studying trends of total failures. A separate database covering this period was compiled and named STUDY.DBF for convenience in doing further analyses.

4. A unique feature of the database report is the fact that it contains information on the age, length, and burial of pipeline segments that was collected from the MMS inventory. The numbers of records with this information are relatively small since it was difficult to identify pipeline segments, in many cases, from the information provided on failure reports.There are enough records, however, to provide some insight or verification of how these factors effect failure rates.

5. A diskette containing all of the databases is provided in Appendix G.

VII. Initial Analyses of the Data and Recommendations for Future Analysis

A. Tabulated Summaries of Data

The following summaries of the database are provided on the following pages:

These tables are representative of some of the information available on the database and of the types of data that can be analyzed. A summary of trends identified from these and other analyses is presented on page 45.

Printouts of condensed versions of the database sorted chronologically and by block number are included in Appendices E and F respectively.

GAS PIPELINE INCIDENTS - FAILURE MECHANISM PER YEAR:

	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	TOTAL
UNKNOWN							2		1	1	1					5	2		1	2	1			1	17
NOT GIVEN					1	1			1			1	2	1			2	1		5	5	9	2		31
ANCHORS							1		1			1	1	2	1		2	1			2	1	5	2	20
NETS									1					1	1	2		1	2	1	3		1		13
WORKBOATS													2			1	2		2			1			8
WAVES														1					1						2
STORMS & HURRICANES					1		1	1	1										15	1		1			21
MUDSLIDES													1						1			2			4
UNSPECIFIED CORROSION							2			1	4	4	4	4	2	3	7					1	4	1	37
EXTERNAL CORROSION				1			1				3	10		2	3	3	10	2	3	5	1	4	8	2	58
INTERNAL CORROSION						1	2					1		3	2	1		2	8	9	14	11	10	7	65
FLANGES, GASKETS, & JOINTS				1		1											1	1	5	1		3	2	4	19
SEAMS & WELDS							1	1												1		1			4
FITTINGS & VALVES									2											2	1				5
CLAMPS						1				1									1	1	1		1		6
MAINT & OPS																			1				1	1	3
OTHER					1	1	1		1								1				2		2		9
TOTAL				2	3	5	11	2	8	3	8	17	10	14	9	15	27	8	34	28	30	34	36	18	322

Oil Pipeline Incidents - Failure Mechanism Per Year:

	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	TOTAL
UNKNOWN			1		1	1		1	1	1						1		1	3	1			4	3	19
NOT GIVEN				4		1			2		2	2	2	1			5	2	2	1		4	2	1	31
ANCHORS	1	1	2	2	2		3	3	3	2	2	3	5	4	1	1	1	1	1		1	2	3	1	45
NETS										1			1	1							1			2	6
WORKBOATS					1			1					1	1	1	1	2	2	1			3		1	15
WAVES					2				1																3
STORMS & HURRICANES								3	1					2					31			6			43
MUDSLIDES								5	3		1		2				2								13
UNSPECIFIED CORROSION									7	1	2	11	14	12	2	7	5	3	3	2	5	1	1	6	82
EXTERNAL CORROSION				1	2	4	1		6	7	6	7	6	1		8	11	5	5	5	6	6	1	2	90
INTERNAL CORROSION					1	1	2		1	4	2	1	1	1	1					1	4	1	5	12	38
FLANGES, GASKETS, & JOINTS								1	1		2	2		1				2	1	1		5	1	5	22
SEAMS & WELDS						1				1	2										1	1	1	1	8
FITTINGS & VALVES						1			1																2
CLAMPS									1			1					1		1			1			5
MAINT & OPS									1			1										2		2	6
OTHER			1	1	1	1	1																		5
TOTAL	1	1	4	8	10	10	7	14	29	17	19	28	32	24	5	18	27	16	48	11	18	32	18	36	433

ALL PIPELINE INCIDENTS - FAILURE MECHANISM PER YEAR:

	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	TOTAL
UNKNOWN	1		1	1	1	1	2	1	3	2	1					6	2	1	4	3	1		5	4	40
NOT GIVEN				4	1	3			2	1	2	3	5	2	1	1	8	5	3	8	5	14	7	1	76
ANCHORS	1	1	1	2	2	1	4	3	5	2	2	5	7	7	6	2	3	2	1	1	4	3	9	3	77
NETS									1	1			1	2	1	2		1	2	1	4		1	2	19
WORKBOATS					1			1					3	1	1	2	4	4	1		1	7	1	1	28
WAVES					2				1					2					1						6
STORMS & HURRICANES					1		1	4	2					2					55	2		13			80
MUDSLIDES								5	3		1		3				5		1			2			20
UNSPECIFIED CORROSION							2		9	2	8	16	20	22	11	20	13	4	5	2	5	3	6	7	155
EXTERNAL CORROSION				2	2	4	2		6	7	10	18	8	8	8	20	24	10	8	14	7	11	13	4	186
INTERNAL CORROSION					1	2	4		1	4	2	2	2	4	7	1		2	2	12	19	13	17	20	115
FLANGES, GASKETS, & JOINTS				1		1		1	1		2	2		1	1		1	6	7	4		8	3	11	50
SEAMS & WELDS						1	1	1		1	2									1	1	2	1	2	13
FITTINGS & VALVES						1			3											2	1				7
CLAMPS						1			1	1		1				2	1		2	1	1	2	1		14
MAINT & OPS									1			2							1			2	1	3	10
OTHER			2	1	5	2	2		1								2				1	2	2		20
TOTAL	2	1	4	11	16	17	18	16	40	21	30	49	49	51	36	56	63	35	93	51	50	82	67	58	916

Gas Pipeline Incidents - Failure Mechanism Per Month:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
UNKNOWN	5	2			1	2	2	2		2	1	1	18
NOT GIVEN	2	1	1	1	2	7	5	3	3	1	4	1	31
ANCHORS (ALL TYPES)	1	2	1	1	1	1	1	2	3	3	1	3	20
NETS	2				2	1		1	2	3	1	1	13
WORKBOATS	1			1	1	1	1	1	2				8
WAVES										1	1		2
STORMS & HURRICANES	2							1	4	11	2	1	21
MUDSLIDES				1	1				1	1			4
UNSPECIFIED CORROSION	5	3	8	2	4	5	2	4	2	1		2	38
EXTERNAL CORROSION	6	3	1	4	5	9	3	7	8	5	2	5	58
INTERNAL CORROSION	7	7	7	3	1	5	10	5	7	3	4	7	66
FLANGES, GASKETS, & JOINTS		2	3	1	3		3	1	2	1	1	2	19
SEAMS & WELDS	1				1				1		1		4
FITTINGS & VALVES	1					1		1	1	1			5
CLAMPS	3				1	1			1				6
MAINT & OPS			1	1		1							3
OTHER	2	1	1			1	1		1	1		1	9
TOTAL	38	21	23	15	23	35	28	28	38	34	18	24	325

Oil Pipeline Incidents - Failure Mechanism Per Month:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
UNKNOWN	2	1	2			1	1	3	5	2	1	1	19
NOT GIVEN	3	2	5	4	2	1	4	3	3	1	3		31
ANCHORS (ALL TYPES)	5	5	2	2	4	6	4	4	2	5	4	3	46
NETS	1						1		1		2	1	6
WORKBOATS	2		2		2	1	2			1	3	2	15
WAVES					1				1			1	3
STORMS & HURRICANES	1							2	17	23			43
MUDSLIDES	2	1	2				1		7				13
UNSPECIFIED CORROSION	6	11	6	6	7	8	10	7	3	7	6	7	84
EXTERNAL CORROSION	3	6	5	7	8	13	8	13	11	10	3	4	91
INTERNAL CORROSION	1	5	3	1	1	7	7	1	3	5	5	2	41
FLANGES, GASKETS, & JOINTS	3	2	1	2	3	2	2	1	2		4	3	25
SEAMS & WELDS	1		2	1	1					1		2	8
FITTINGS & VALVES									1		1		2
CLAMPS	1			1	2						1		5
MAINT & OPS			1	2	2			1		1		1	8
OTHER	2	1			1			1		1			6
TOTAL	33	34	31	26	34	39	40	36	56	57	33	27	446

All Pipeline Incidents - Failure Mechanism Per Month:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
UNKNOWN	7	4	2		2	4	3	5	5	5	2	2	41
NOT GIVEN	5	3	8	8	6	10	9	7	8	3	8	2	77
ANCHORS (ALL TYPES)	9	7	3	4	5	9	7	7	5	9	6	8	79
NETS	3				2	1	1	1	3	3	3	2	19
WORKBOATS	4	2	2	1	2	1	3	1	3	1	4	4	28
WAVES					1				1	1	2	1	6
STORMS & HURRICANES	3				1			3	29	39	4	1	80
MUDSLIDES	5	1	2	1	1		1		8	1			20
UNSPECIFIED CORROSION	11	16	16	11	12	18	16	15	7	13	11	13	159
EXTERNAL CORROSION	12	13	10	14	16	28	15	23	19	17	7	13	187
INTERNAL CORROSION	8	15	10	4	6	13	18	8	10	9	9	9	119
FLANGES, GASKETS, & JOINTS	3	5	4	3	8	2	6	4	5	1	6	5	52
SEAMS & WELDS	2		2	1	2				2	1	1	2	13
FITTINGS & VALVES	1					1		1	2	1	1		7
CLAMPS	5			1	3	1			1	1	1	1	14
MAINT & OPS			3	3	2	1		1		1		1	12
OTHER	2	2	2		1	1	1	4	1	2	4	1	21
TOTAL	80	68	64	51	70	90	80	80	109	108	69	95	934

Gas Pipeline Incidents - Failure Mechanism Per Nominal Diameter:

	2 IN.	3 IN.	4 IN.	6 IN.	8 IN.	10 IN.	12 IN.	14 IN.	16 IN.	18 IN.	20 IN.	22 IN.	24 IN.	30 IN.	36 IN.	TOTAL
UNKNOWN			4	1	2	2	2		1		3		1	1		16
NOT GIVEN	2	2	4	3	5	1	6		3	1	1					29
ANCHORS (ALL TYPES)	5	1	4	2	2	1	1	1		1	1					19
NETS	4			1	1	2	2		1	1						12
WORKBOATS	1	4			1		1	1								8
WAVES	1															1
STORMS & HURRICANES	3	4	8	2	1	1				2						21
MUDSLIDES						2	2									4
UNSPECIFIED CORROSION	14	7	4	5		1	1		3		2					37
EXTERNAL CORROSION	12	13	9	11	4	3			1		4		1			58
INTERNAL CORROSION	3	2		2	5	11	18		7		12	1	4			65
FLANGES, GASKETS, & JOINTS	1			2	4		4		1		1		1		4	18
SEAMS AND WELDS									1		1	1	1			4
FITTINGS & VALVES	1					1	1		2							5
CLAMPS			1	2			1		2							6
MAINT & OP										1				1		2
OTHER			1	2	3	1		1	1							9
TOTAL	47	33	35	33	28	26	39	3	23	6	25	2	8	2	4	314

Oil Pipeline Incidents - Failure Mechanism Per Nominal Diameter:

	2 IN.	3 IN.	4 IN.	6 IN.	8 IN.	10 IN.	12 IN.	14 IN.	16 IN.	18 IN.	20 IN.	22 IN.	24 IN.	30 IN.	36 IN.	TOTAL
UNKNOWN			7	3	1	2	2				1					16
NOT GIVEN	3		9	9	4	1	4	1								31
ANCHORS (ALL TYPES)			5	15	3	2	9	4		1						39
NETS			3	1	1	1										6
WORKBOATS	3	1	1	4	3	1	1			1						15
WAVES			2	1												3
STORMS & HURRICANES	1	8	12	7	10	4	1									43
MUDSLIDES				1	4	1	6									12
UNSPECIFIED CORROSION	5	9	26	16	13	4	5	1	1							80
EXTERNAL CORROSION	5	12	24	23	14	6	5		1							90
INTERNAL CORROSION	1	3	9	5	4	2	5	2	3	2						36
FLANGES, GASKETS, & JOINTS		2	2	5	7	1	3									20
SEAMS AND WELDS	1			2		1	2	1						1		8
FITTINGS & VALVES			1		1											2
CLAMPS				2	1	1	1									5
MAINT & OP		1		2						1						4
OTHER			1	2	1											4
TOTAL	19	36	102	98	67	27	44	9	5	5	1			1		414

All Pipeline Incidents - Failure Mechanism Per Nominal Diameter:

	2 IN.	3 IN.	4 IN.	6 IN.	8 IN.	10 IN.	12 IN.	14 IN.	16 IN.	18 IN.	20 IN.	22 IN.	24 IN.	30 IN.	36 IN.	TOTAL
UNKNOWN	1		12	4	3	4	5		1		4			1		35
NOT GIVEN	5	4	15	14	11	4	13	1	3	1	1		1			73
ANCHORS (ALL TYPES)	9	2	11	20	15	3	10	5		2	1					78
NETS	4		3	2	2	3	2		1	1						18
WORKBOATS	4	5	2	6	4	2	1	2		2						28
WAVES	1		2	2												5
STORMS & HURRICANES	7	21	20	12	11	6	1			2						80
MUDSLIDES				3	5	3	8									19
UNSPECIFIED CORROSION	23	23	40	31	16	6	7	2	4		2					154
EXTERNAL CORROSION	22	37	43	40	20	10	5		2		6		1			186
INTERNAL CORROSION	4	6	13	8	11	16	25	2	10	2	12	1	4			114
FLANGES, GASKETS, & JOINTS	1	3	2	11	12	2	8		2		1		1		4	47
SEAMS AND WELDS	1	1		2		1	2	1	1		1	1	1	1		13
FITTINGS & VALVES	1		1		1	1	1		2							7
CLAMPS	1		1	5	1	1	2		1							11
MAINT & OP		1		3						2				1		7
OTHER	1	1	3	3	9	3		1	1	1						23
TOTAL	85	104	168	166	121	65	90	14	28	13	28	2	8	3	4	899

Corrosion Failure Versus Pipeline Age:

	1-2 YRS	3-4 YRS	5-6 YRS	7-8 YRS	9-10 YRS	11-12 YRS	13-14 YRS	15-16 YRS	17-18 YRS	19-20 YRS	20+ YRS	TOTAL
UNSPECIFIED CORROSION	3	3	1	7	5	8	6	4	5	0	4	46
INTERNAL CORROSION	2	1	7	15	11	2	1	2	3	0	3	47
EXTERNAL CORROSION	0	3	4	6	4	17	9	3	7	3	16	72
TOTAL	5	7	12	28	20	27	16	9	15	3	23	115

Failure Mechanisms Versus Burial:

	TOTAL FAILURES	NUMBER BURIED	NUMBER NOT BURIED	NUMBER SURFACE
ANCHORS	79	17	14	2
NETS	19	5	3	0
WORKBOATS	28	4	6	0
WAVES	6	0	1	0
STORMS & HURRICANES	80	12	33	7
MUDSLIDES	20	5	7	0

B. Summary of Trends Identified from Initial Analyses:

1. An offshore pipeline failure occurs in the Gulf of Mexico OCS Region every five days. This figure is based on the period of data which was represented by the most sources of failure records.

2. A separate pipeline failure occurs approximately every six days in state waters, bays, and bayous of the Gulf of Mexico. This figure is based on information from the National Response Center and includes refined products.

3. The number of total failures (GOM OCS) has been fairly constant over the last ten years. The average is 59 failures with a standard deviation of 18 failures based on a normal distribution.

4. The numbers of failures due to internal corrosion have increased markedly in the last five years.

5. The numbers of failures at flanges has increased (presumably as their use has become more common). The only recorded failures for the largest pipelines (36" diam.) occurred at flanges. Weld failures have remained very low in spite of the increased total inventory of pipelines over the years.

6. Corrosion seemed to show up as a failure mechanism in pipelines of around 10 years of age or in pipelines over 20 years old. This variability is likely a function of the diligence of the operator's corrosion prevention program.

7. 40 of 52 pipelines damaged by storms for which burial information was available were not buried or surface mounted(risers). This would appear to support an assumption that burial of pipelines on the average provides better protection from both hydrodynamic or geotechnical/ hydrodynamic forces, however, the decision to undergo the expense of burying a pipeline should be made on a case by case basis. This decision should include options of applying the money saved from not burying the pipeline to other programs for avoiding and mitigating failures.

8. Visual techniques are the most common means of detecting pipeline failures. This information was collected for 16 failures. One leak was detected by an ROV, the others were observed from the air or from a platform.

VIII. Recommendations for Future Data Collection

These recommendations are made based on the following premises:

1. Collection of failure reports is required to ensure adequate operation and regulation of offshore pipelines.
2. If data is to be collected, it should be of sufficient detail and completeness to provide for a retrospective analysis of trends and correlations between failure rate and characteristics of the environment, the pipeline type and configuration, and operator performance.
3. Reporting should be streamlined so as not to overburden either operators or regulators.

Recommendations:

1. The DOT, MMS, and NRC should agree on a specific format for offshore pipeline failure reports. These reports should preferably be uniquely designed and maintained for offshore pipelines. Further, if they have not done so already, the regulators should create a system so that this information can be shared among agencies and among pipeline operators. A central electronic database and electronic reporting formats would greatly facilitate this process.

2. A coordinated approach to identifying pipeline segments similiar to the system used in the MMS inventory should be developed between regulators and operators.

3. Methods of identifying geographical locations similar to the Gulf of Mexico OCS Region block description and block numbers should be instituted for other regions.

4. A review of the quantifiable characteristics of the pipeline operating environment presented in Section III of this report will facilitate development of agreements between regulators and operators on the information to be collected.

5. Failure reports should be verified for completeness and accuracy prior to their acceptance. Forms designed specifically for offshore pipelines and increased involvement by operators in data collection should ease this process.

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APPENDIX A: SAMPLE DATA SHEETS:

Samples of incident reports from the following sources are included:

...penalty shall not exceed $200,000 as provided in 49 USC 1678 — Form Approved OMB No 2137 05

Research and Special Programs Administration

INCIDENT REPORT — GAS TRANSMISSION AND GATHERING SYSTEMS

Report Date ______
No ______
RSPA: 1322
?? - 12430

900088

PART 1 — GENERAL REPORT INFORMATION

SEE INSTRUCTIONS

1 a Operator's 5 digit identification no 0 0 4 0 5
b Name of Operator ANR Pipeline Company
c. 500 Renaissance Center
Number and Street
d. Detroit, Michigan 48243
City, County, State and Zip Code

2. Location of Incident
a Eugene Island Block 266
City and County
b. Offshore Louisiana, Federal Waters, Gulf of Mexico
State and Zip Code
c Mile Post/Valve Stat x = 1,881,731.56
d. Survey Station No y = -66,264.35
e Class Location
Onshore ☐ 1 ☐ 2 ☐ 3 ☐ 4
Offshore ☒ Eugene Island Block 266 (area / block number)
State ______ or Outer Continental Shelf x
f Incident on Federal Land other than Outer Continental Shelf
☐ Yes ☒ No

3. Incident Type
☒ Leak ☐ Rupture ☐ Other
Rupture Length (feet) ______

4 Reason for Reporting
☐ Fatality — Number ______ persons
☐ Injury requiring inpatient hospitalization — Number ______ persons
☒ Property damage/loss — Estimated $ 63,000
☐ Operator Judgment
☐ Supplemental Report

5. Elapsed time until area was made safe
______ hr ______ mn

6 Telephonic Report
0 3 mo 1 3 day 9 0 yr

7. a Estimated Pressure at Point and Time of Incident (PSIG) 880
b. Maximum allowable operating pressure (MAOP) (PSIG) 1250
c. MAOP established by
(1) Test pressure 2683 (PSIG)
(2) 49 CFR §192.619(a)(3) ☐

8 Time and Date of the Incident
1 6 3 5 hour CST 0 3 mo 1 2 day 9 0 yr

PART 2 — APPARENT CAUSE

☒ Corrosion (Continue in Part A)
☐ Damage by Outside Forces (Continue in Part B)
☐ Construction Material Defect (Continue in Part C)
☐ Other ______

PART 3 — NARRATIVE DESCRIPTION OF FACTORS CONTRIBUTING TO THE INCIDENT

(Attach additional sheet(s) as necessary)

PART 4 — ORIGIN OF THE INCIDENT

1. Incident Occurred On
☒ Transmission System ☐ Gathering System
☐ Transmission Line of Distribution System

2. Failure Occurred On:
☒ Body of Pipe ☐ Fitting, Specify ______
☐ Mechanical Joint ☐ Other, Specify ______
☐ Valve ☐ Weld, Specify ______ *(girth, longitudinal, fillet)*

3 Material Involved:
☒ Steel ☐ Other, Specify ______

4 Part of System Involved in Incident
a Part
☒ Pipeline ☐ Regulator/Metering System
☐ Compressor Station ☐ Other ______
b. Year installed 1 9 7 0

PART 5 — MATERIAL SPECIFICATION

1 Nominal Pipe Size 0 0 1 2 in
2 Wall Thickness 0 . 3 7 5 in
3 Specification API-5LX SMYS 4 6 0 0 0
4 Seam Type ERW
5. Valve, Type ______
6 Manufactured by American Steel in year 1 9 7 0

PART 6 — ENVIRONMENT

Area of Incident
☐ Under Pavement ☐ Above Ground
☐ Under Ground ☐ Under Water
☐ Other ______

PART 7 — PREPARER AND AUTHORIZED SIGNATURE

Donald E. Cross, C.S. & P.
(type or print) Preparer's Name and Title

313 / 496-2460
Telephone Number

______
Authorized Signature and Date

(313) / 496-3512
Telephone Number

Form RSPA F 7100.2 (3 84)

PART A – CORROSION

1. Where did corrosion occur?
   - ☒ Internally
   - ☐ Externally
2. Visual Description
   - ☒ Localized Pitting
   - ☐ General Corrosion
   - ☐ Other ____________
3. Cause
   - ☐ Galvanic
   - ☐ Other ____________
4. Pipe Coating Information
   - ☐ Bare ☒ Coated
5. Was corroded part of pipeline considered to be under cathodic protection prior to discovering incident?
   - ☒ Yes Year Protection Started /1/9/7/0/
   - ☐ No
6. Additional Information

PART B – DAMAGE BY OUTSIDE FORCES

N/A

1. Primary Cause of Incident
   - ☐ Damage resulted from action of operator or his agent
   - ☐ Damage resulted from action by outside oarty/third party
   - ☐ Damage by earth movement
     - ☐ Subsidence
     - ☐ Landslide/Washout
     - ☐ Frost
     - ☐ Other ____________
2. Locating information *(for damage resulting from action of outside party/third party)*
   a. Did operator get prior notification that equipment would be used in the area?
      - ☐ Yes Date received /_/_/ mo /_/_/ day /_/_/ yr
      - ☐ No

   b. Was pipeline location marked either as a result of notification or by markers already in place?
      - ☐ Yes Specify type of marking: ____________
      - ☐ No

   c. Does Statute or ordinance require the outside party to determine whether underground facility(ies) exist?
      - ☐ Yes
      - ☐ No
3. Additional Information

PART C – CONSTRUCTION OR MATERIAL DEFECT

N/A

1. Cause of Defect
   - ☐ Construction ☐ Material *(describe in C.4 below)*
2. Description of Component Other than Pipe
3. Latest Test Data
   a. Was part which leaked pressure tested before incident occurred?
      - ☐ Yes Date of Test /_/_/ mo /_/_/ day /_/_/ yr
      - ☐ No

   b. Test Medium ☐ Water ☐ Gas ☐ Other ____________

   c. Time held at test pressure /_/_/ hr

   d. Estimated test pressure at point of incident *(psig)* ____________
4. Additional Information

RECEIVED
OPS-1
90 MAR 29 AM 11:55
900088

Report Date 1-10-86

No. 7000-1 (DOT)

ACCIDENT REPORT-HAZARDOUS LIQUID PIPELINE

860010

PART A—OPERATOR INFORMATION

1.) Name of operator ARCO Pipe Line Company

2.) Principal business address ARCO Building

Independence, Kansas 67301

(city) (state) (zip code)

3.) Is pipeline interstate? ☒ yes ☐ no

PART B—TIME AND LOCATION OF ACCIDENT

1.) Date: (month) December (day) 20 (year) 1985

2.) Hour (24 hour clock) 1500

3.) If onshore give state *(including Puerto Rico and Washington, D.C.)*, and county or city.

4.) If offshore, give offshore coordinates South Pass Block 60, x = 2,760,143, y = 151,655

5.) Did accident occur on Federal Land? ☒ yes ☒ no per R. Brown 1/13/86

(See instructions for definition of Federal Land.)

6.) Specific location *(If location is near offshore platforms, buildings, or other landmarks, such as highways, waterways, or railroads, attach a sketch or drawing showing relationshp of accident location to these landmarks)*

Approx. 750 feet southeast of South Pass Block 60 Platform "C" in the Gulf of Mexico

PART C—ORIGIN OF RELEASE OF LIQUID OR VAPOR.

(Check all applicable items)

1.) Part of system involved:

☒ line pipe ☐ tank farm ☐ pump station

2.) Item Involved: ☒ pipe ☐ valve ☐ scraper trap ☐ pump ☐ welding fitting ☐ girth weld ☐ tank ☐ bolted fitting ☐ longitudial weld

Other *(specify)*

3.) Year item installed 1973

PART D—CAUSE OF ACCIDENT

☐ corrosion ☐ failed weld ☐ incorrect operation by operator personnel

☐ failed pipe ☐ outside force damage

☐ malfunction of control or relief equipment.

☒ other *(specify)* Buckled due to Unknown reasons

PART E—DEATH OR INJURY

1.) Number of persons killed. 0

____ Operator employees ____ Non-employees

2.) Number of persons injured. 0

____ Operator employees ____ Non-employees

PART F—ESTIMATED TOTAL PROPERTY DAMAGE

$ None to outside parties -- only a sheen on the water resulted from this leak.

PART G—COMMODITY SPILLED

1.(Name of commodity spilled: Crude Oil

2.) Classification of commodity spilled:

☐ Petroleum Petroleum product ☐ HVL or ☒ Non-HVL

3.) Estimated amount of commodity involved

3 Barrels spilled 0 Barrels recoverd

4.) Was there an explosion?

☐ yes ☒ no

5.) Was there a Fire?

☐ yes ☒ no

PART H—OCCURRED IN LINE PIPE

1.) Nominal diameter *(inches)* 6" 2.) Wall thickness *(inches)* .344"

3.) SMYS *(psi)* 35,000 4.) Type of joint: ☒ welded ☐ flanged ☐ threaded ☐ coupled ☐ other

5.) Pipe was ☒ Below ground ☐ Above ground (submerged)

6.) Maximum operating pressure *(psig)* 1440

7. Pressure at time and location of accident *(psig)* 400

8.) Had there been a pressure test on system?
☒ yes ☐ no

9.) Duration of test *(hrs)* 8

10.) Maximum test pressure *(psig)* 1893

11.) Date of latest test 7-3-83

PART I—CAUSED BY CORROSION

1. Location of corrosion
☐ internal ☐ external

2. Facilty coated?
☐ yes ☐ no

3. Facilty under cathodic protection?
☐ yes ☐ no

4. Type of corrosion
☐ galvanic ☐ other *(Specify)*

PART J—CAUSED BY OUTSIDE FORCE

1. ☐ Damage by operator or its contractor
☐ Damage by others
☐ Damage by natural forces
☐ Landslide
☐ Subsidence
☐ Washout
☐ Frostheave
☐ Earthquake
☐ Ship anchor
☐ Mudslide
☐ Fishing Operations
Other Unknown at this time

2. Was a damage prevention program in effect
☒ yes ☐ no

3. If yes, was the program
☐ "one-call" ☒ other AOGC Anchor Procedure

4. Did excavator call? N/A
☐ yes ☐ no

5. Was pipeline location temporarily marked for the excavator?
☐ yes ☐ no N/A

PART K—ACCOUNT OF ACCIDENT

On Friday, December 20, 1985, at approximately 3:00 P.M., a sheen was detected on surface of the water approximately 750 feet southeast of South Pass Block 60 "C" Platform. Investigation by divers revealed a buckle in the pipeline. A seepage from buckled pipe was determined to be the location of the leak.

RECEIVED 1986 JAN 21

860010

NAME AND TITLE OF OPERATOR OFFICIAL FILING THIS REPORT

V. P. Driski V. P. Driski, Regional Manager

316-331-1300 1-13-86
Telephone no. *(Including area code)* Date

DOT Form 7000-1 (4-85)

PIPELINE LEAKS

Date	Degree of Pollution	Company	Line Size/Service		Location of Leak	Location of Line	Description of Cause	Corrective Action
July 1, 1986	6 1/4 bbls	ANR	10"	Gas	250' from VR 242A	VR 242A VR 241 20"SSTI	Pin hole leak in 10" line. Internal Corrosion.	Install Clamp over leak.
July 7, 1986	0	ANR	10"	Gas	X = 1,449,888.32 Y = 47,806.61	WC 281P WC 280 30"SSTI	Suspected Internal Corrosion	Cut out and replaced 68' of 10" pipe. Installed a hydrotech coupling on both ends.
#17 July 9, 1986	0	Tennessee	12"	Gas	200 yards east of Conoco WC 192A X = 1,451,539 Y = 232,147	WC 192A WC 192E	The leak was determined to be a hole 1" long and 3/8" wide in the 6 o'clock position of the pipe. There was no evidence of external corrosion.	A 12"x1500 psi WP Plidco clamp was installed over the leak. All repairs done in compliance with applicable DOT Regulations.
July 11, 1986	0	Exxon	12"	Gas	Between HI 342 B and HI 343 A	HI A 342 "B" to HI A 343 A	The incident was due to internal corrosion.	This lateral has been shut down and has not been repaired pending review and negotiation with Exxon Co who is the operator.
July 15, 1986	0	Sea Robin	36"	Gas	VR Block 72 leak located at X = 1,728,572 Y = 216,655	VR 149 PP to SMI 209 (3 mi)	Flange bolts were loose on the hot tap flange.	The leak was stopped by tightening the flange bolts on the 16" hot tap in Vermilion Block 72.
Aug 14, 1986	0	Texaco	6"	Oil	In 6" [redacted] "J" take on EI 206 "A" ft.	EI 206 "A" EI 215 "B"	Leak in 6" riser at the +4' elevation, cause by external corrosion.	A 15' section of new 6" x .432 Grade "B" pipe was welded on. Pipe clamps at elevation -20' and +10' were installed and the pipe was lifted into position. A mating 6" schedule 80 900[illegible] RTJWN flange was welded on the riser and the riser was then flanged to the spool section.

53

OPTION : REGION

UNITED STATES DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE
GULF OF MEXICO OCS REGION
SEGMENT LIST IN "COMES FROM" ORDER

OIS ID: LSTFRM
DATE: 08/20/91
PAGE: 1

SEGMENT NUMBER	COMES FROM AR	BLOCK	I.D	GOES TO AR	BLOCK	I.D	SIZE	PIPELINE LENGTH	SERVICE	STATUS	AUTH	APPROVAL CODE	APPROVAL DATE	CONST. DATE	MAOP	BUP	OPERATOR CODE	OPERATOR NAME
009192	BA	0375	#01	BA	0376	"A"	06	017959	BLKG	ACT	I	L	10/05/90	10/28/90	02160	Y	00985	UNION EXPLORAT
009212	BA	0376	"A"	BA	0366	F/S	06	017521	S/C	ACT	T	R	10/16/90	11/03/90	01440	Y	01550	UNOCAL EXPLORA
009332	BA	0399	"A"	BA	0399	12"SSTI	12	002215	S/C	PROP	T	R	02/21/91	00/00/00	01051	Y	01074	TRANSCO OFFSHO
009456	BA	0399	#01	BA	0399	"A"	04	004778	BLKG	PROP	I	L	08/06/91	00/00/00	03705	Y	00672	SEAGULL ENERGY
009241	BA	0399	#02	BA	0399	12"SSTI	06	00211[illegible]	S/C	PROP	T	R	12/04/90	00/00/00	01051	Y	01074	TRANSCO OFFSHO
009457	BA	0399	#02	BA	0399	"A"	04	001353	BLKG	PROP	I	L	08/06/91	00/00/00	03705	Y	00672	SEAGULL ENERGY
009471	BA	0399	#020	BA	0399	"A"	04	001353	BLKG	PROP	I	L	08/06/91	00/00/00	03705	Y	00672	SEAGULL ENERGY
009458	BA	0399	#03	BA	0399	"A"	04	004084	BLKG	PROP	I	L	08/06/91	00/00/00	03705	Y	00672	SEAGULL ENERGY
009459	BA	0399	#05	BA	0399	"A"	04	009760	BLKG	PROP	I	L	08/06/91	00/00/00	03705	Y	00672	SEAGULL ENERGY
009472	BA	0399	#050	BA	0399	"A"	04	009760	BLKG	PROP	I	L	08/06/91	00/00/00	03705	Y	00672	SEAGULL ENERGY
009240	BA	0399	CAP	BA	0412	CAP	12	045790	S/C	PROP	T	R	11/20/90	00/00/00	01051	Y	01074	TRANSCO OFFSHO
008866	BA	0411	#01	BA	0436	#03	06	008289	BLKG	ACT	I	L	10/26/89	11/17/89	01480	Y	00538	CORPUS CHRISTI
009030	BA	0412	"A"	BA	0412	12"SSTI	06	000367	GAS	ACT	T	R	04/24/90	05/22/90	01051	Y	01074	TRANSCO OFFSHO
009031	BA	0412	CAP	BA	0451	30"SSTI	12	062229	GAS	ACT	T	R	04/24/90	05/22/90	01051	Y	01074	TRANSCO OFFSHO
009018	BA	0435	"A"	BA	0412	"A"	04	011088	BLKG	ACT	I	L	06/06/90	07/24/90	01450	Y	00992	DIAMOND SHAMRO
007991	BA	0436	"A"	BA	0437	#07	04	005901	BLKG	ACT	I	L	12/18/86	03/10/87	01440	Y	00538	CORPUS CHRISTI
007647	BA	0436	#03	BA	0437	#07	06	015195	BLKG	ACT	I	L	10/02/85	04/20/88	01440	Y	00538	CORPUS CHRISTI
006233	BA	0437	#01	BA	0437	08"SSTI	06	003784	S/C	ACT	T	L	08/14/81	12/03/81	01250	Y	00011	TRANSCONTINENT
006151	BA	0437	#02	BA	0438	F/S	06	014515	S/C	ACT	T	R	09/14/81	12/24/81	01440	Y	00011	TRANSCONTINENT
007477	BA	0437	#07	BA	0437	#02	06	010304	BLKG	ACT	I	L	05/16/85	09/13/85	01723	Y	00536	CORPUS CHRISTI
007670	BA	0437	#07	BA	0452	12"SSTI	08	004665	S/C	ACT	T	R	09/04/85	11/04/85	01248	Y	00011	TRANSCONTINENT
007052	BA	0435	#01	BA	0437	#02	04	004992	BLKG	ACT	I	L	03/04/84	09/12/85	02609	Y	00533	CORPUS CHRISTI
009106	BA	0449	"A"	BA	0459	F/S	04	015875	S/C	CNCL	T	R	00/00/00	00/00/00			00730	WALTER OIL & G
006560	BA	0451	"A"	BA	0474	30"SSTI	08	012329	GAS	ACT	T	R	10/22/82	12/07/82	01248	Y	00169	ANR PIPELINE C
008272	BA	0452	#01	BA	0437	PLAT#07	04	004189	BLKG	ACT	I	P	02/24/88	04/08/88	01440	Y	00276	EXXON CORPORAT
007669	BA	0453	"A"	BA	0474	30"SSTI	12	037555	S/C	ACT	T	P	09/04/85	11/05/85	01249	Y	00011	TRANSCONTINENT
009160	BA	0476	"A"	BA	0475	12"SSTI	06	005174	GAS	PROP	T	L	10/31/90	00/00/00	01051	Y	00105	APACHE CORPORA
009161	BA	0475	#02	BA	0476	"A"	03	011028	BLKG	PROP	I	L	10/31/90	00/00/00	03030	Y	00105	APACHE CORPORA
009029	BA	0491	"A"	BA	0491	12"SSTI	06	000333	S/C	ACT	T	R	05/23/90	07/01/90	01051	Y	01074	TRANSCO OFFSHO
009028	BA	0491	CAP	BA	0451	30"SSTI	12	052852	S/C	ACT	T	R	05/25/90	07/01/90	01051	Y	01074	TRANSCO OFFSHO
008624	BA	0494	"A"	BA	0474	30"SSTI	04	017614	S/C	PROP	T	R	05/05/89	00/00/00	01050	Y	1334	NERCO OIL & GA
006168	BA	0504	"A"	BA	A0001	20"SSTI	10	016130	S/C	ACT	T	R	08/24/81	11/05/81	01440	Y	00011	TRANSCONTINENT
008953	BA	0517	#01	MI	0518	F/S	06	022143	BLKG	PROP	T	L	01/25/90	00/00/00	02417	Y	00114	AMOCO PRODUCTI
009052	BA	0517	#01	MI	0467	"A"	05	00[illegible]112	BLKG	ACT	I	L	05/07/90	10/25/90	03705	Y	01023	ADOBE RESOURCE
001548	BA	0535	"A"	BA	0439	F/S	30	038321	GAS	ACT	T	P	03/24/71	10/30/73	01051		00011	TRANSCONTINENT
007262	BA	0538	"A"-	BA	0439	F/S	36	087635	GAS	ACT	T	R	04/16/85	10/19/85	01440	Y	00011	TRANSCONTINENT
001551	BA	0541	"A"	BA	0541	08"SSTI	20	001292	RLNG	ABN	T	R	06/03/71	01/06/75	01440		00011	TRANSCONTINENT
001638	BA	0541	20"SSTI	BA	0541	20"SSTI	08	000315	RLNG	REM	T	R	10/04/72	01/05/75	01440	Y	00011	TRANSCONTINENT
004166	BA	0541	20"SSTI	BA	0538	"A"	20	049411	GAS	ACT	T	R	06/03/71	12/10/74	01440		00011	TRANSCONTINENT
008675	BA	0550	"A"	BA	0510	30"SSTI	36	091759	GAS	ACT	T	R	06/01/89	09/22/89	01440	Y	00730	WALTER OIL & G
008694	BA	0572	"A"	BA	0550	"A"	04	021587	S/C	ACT	T	L	06/20/89	10/09/89	01451	Y	00730	WALTER OIL & G
006315	BA	0578	"A"	BA	0578	24"SSTI	10	021343	S/C	ACT	T	L	01/04/82	05/02/82	01440	Y	00011	TRANSCONTINENT
008693	BA	0565	"A"	BA	0572	"A"	04	010471	BLKG	ACT	I	L	07/06/89	10/09/89	01480	Y	00730	WALTER OIL & G
004167	BA	A0001	"A"	BA	0541	20"SSTI	20	036333	GAS	ACT	T	R	10/04/72	12/10/74	01440		00011	TRANSCONTINENT

APPENDIX B: DATABASE FIELD DESCRIPTIONS:

Descriptions of the fields used in the following database are provided:

The database "**PIPELINE.DBF**" is organized as follows:

FIELD	TYPE	WIDTH	DEC	DESCRIPTION
REF	C	3	0	DESCRIBES SOURCE OF INFORMATION
MMS_INFO	L	1	0	DESCRIBES SOURCE OF INFORMATION
DOT_INFO	L	1	0	DESCRIBES SOURCE OF INFORMATION
OP_ID_NO	C	5	0	OPERATOR IDENTIFICATION NUMBER
OP_NAME	C	40	0	OPERATOR NAME
OP_STREET	C	40	0	OPERATOR ADDRESS
OP_CITY	C	20	0	OPERATOR CITY
OP_STATE	C	2	0	OPERATOR STATE
OP_ZIP	C	5	0	OPERATOR ZIP CODE
INC_STATE	C	2	0	STATE IN WHICH INCIDENT OCCURRED
INTERSTATE	L	1	0	LOGICAL: INTERSTATE PIPELINE?
FEDERAL	L	1	0	LOGICAL: FEDERAL JURISDICTION?
MP_VLV_STA	C	20	0	MILE POST/VALVE STATION
SURV_STA	C	40	0	SURVEY STATION OR LAT. AND LONG.
BLOCK_DESC	C	3	0	TWO LETTER ABBR. FOR GOM BLOCK NAME
BLOCK_NUMB	C	5	0	GOM BLOCK NUMBER
PLATFORM	C	3	0	PLATFORM DESIGNATION
LOC_MEMO	M	10	0	AMPLIFYING INFORMATION ON LOCATION
INC_TYPE	C	10	0	TYPE OF INCIDENT:LEAK, RUPTURE OR OTHER
RUP_LENGTH	C	10	0	LENGTH OF RUPTURE IN FEET
NO_FATAL	N	3	0	NUMBER OF FATALITIES
NO_INJ	N	3	0	NUMBER OF PERSONS INJURED
AMT_DAMAGE	N	8	0	ESTIMATED PROPERTY DAMAGE
EXPLOSION	L	1	0	LOGICAL:WAS THERE AN EXPLOSION?
FIRE	L	1	0	LOGICAL:WAS THERE A FIRE?
HRSTO_SAFE	N	4	0	EST. TIME UNTIL AREA MADE SAFE
DT_PHON_RP	D	8	0	DATE OF TELEPHONIC REPORT
INC_PRESS	N	4	0	PRESS. AT POINT AND TIME OF INCIDENT (PSIG)
MAOP	N	4	0	MAX. ALLOWABLE OPERATING PRESSURE (PSIG)
TEST_PRESS	N	4	0	TEST PRESS. USED TO ESTABLISH MAOP (PSIG)
CFR	L	1	0	LOGICAL: MAOP ESTABLISHED BY 49 CFR 192.619?
INC_TIME	C	4	0	TIME OF INCIDENT
INC_DATE	D	8	0	DATE OF INCIDENT
AP_CAUSE	C	20	0	APPARENT CAUSE OF INCIDENT
PRODUCT	C	10	0	PRODUCT TRANSPORTED
SERVICE	C	10	0	SERVICE CLASSIFICATION PER MMS INVENTORY
CLASSIFICA	C	10	0	CLASSIFICATION OF COMMODITY SPILLED
POL_BBLS	N	8	1	POLLUTION IN BARRELS
SYS_TYPE	C	30	0	SYSTEM TYPE: GATHERING, TRANSMISSION,ETC
SYS_PART	C	30	0	PART OF SYSTEM: PIPELINE, METER,ETC
PART_DAM	C	10	0	PART OF SYSTEM DAMAGED
PLINE_PART	C	40	0	SPECIFIC PART FAILED: WELD, FITTING, ETC
PLINE_MATL	C	10	0	PIPELINE MATERIAL
PIPE_SIZE	N	2	0	NOMINAL DIAMETER OF PIPELINE
PIPE_WALL	N	4	0	WALL THICKNESS x 10^4
PIPE_SPEC	C	20	0	PIPE SPECIFICATION AND SMYS
PIPE_SEAM	C	20	0	SEAM TYPE

Organization of **PIPELINE.DBF** continued:

JOINT_TYPE	C	10	0	TYPE OF PIPE JOINTS USED
PART_AGE	N	2	0	AGE OF PART FAILED
PIPE_AGE	N	2	0	AGE OF PIPELINE
PIPE_MANUF	C	20	0	PIPE MANUFACTURER
MATL_MEMO	M	10	0	AMPLIFYING INFORMATION ON PART FAILED
PREPARER	C	20	0	OPERATOR REPRESENTATIVE FILING REPORT
PREP_PHON	C	12	0	OPERATOR REPRESENTATIVE PHONE NUMBER
CORR_LOC	C	10	0	LOCATION OF CORROSION: INTERNAL, EXTERNAL
CORR_VIS	C	25	0	VISUAL DESCRIPTION OF CORROSION
CORR_CAUSE	C	20	0	CAUSE OF CORROSION
COATED	L	1	0	LOGICAL: WAS PIPELINE COATED?
CATHODIC	L	1	0	LOGICAL: WAS CATHODIC PROTECTION USED?
CATH_DATE	D	8	0	YEAR CATHODIC PROTECTION STARTED
CORR_MEMO	M	10	0	AMPLIFYING INFO ON CORROSION
DAM_CAUSE	C	30	0	CAUSE OF DAMAGE BY OUTSIDE FORCES
DAM_MEMO	M	10	0	AMPLIFYING INFO ON DAMAGE
CONST_CAUS	C	50	0	CAUSE OF CONST OR MATERIAL DEFECT
CONST_MEMO	M	10	0	AMPLIFYING INFO ON CONST OR MATL DEFECT
OTHER_CAUS	C	50	0	OTHER CAUSE DESCRIPTION
OTHER_MEMO	M	10	0	AMPLIFYING INFO ON OTHER CAUSE
CAUSE1	C	10	0	SHORT DESCRIPTION OF PRIMARY CAUSE
CAUSE2	C	10	0	SHORT DESCRIPTION OF SECONDARY CAUSE
SEG_NUMB	N	7	0	MMS SEGMENT NUMBER
LENGTH	N	6	0	LENGTH OF PIPELINE SEGMENT PER MMS INVENTORY
CONST_DATE	D	8	0	DATE PIPLEINE CONSTRUCTED PER MMS INVENTORY
BURIED	C	1	0	BURIED
DETECTION	C	10	0	METHOD BY WHICH LEAK WAS DETECTED
MAX_DEPTH	N	4	0	MAXIMUM DEPTH OF PIPELINE SEGMENT

The database "**GASLIST.DBF**" is organized as follows:

FIELD	TYPE	WIDTH	DEC	DESCRIPTION
DOT_INFO	L	1	0	DESCRIBES SOURCE IN MASTER DATABASE
OP_ID_NO	C	5	0	OPERATOR IDENTIFICATION NUMBER
OP_NAME	C	40	0	OPERATOR NAME
OP_STREET	C	40	0	OPERATOR ADDRESS
OP_CITY	C	20	0	OPERATOR CITY
OP_STATE	C	2	0	OPERATOR STATE
OP_ZIP	C	5	0	OPERATOR ZIP CODE
INC_STATE	C	2	0	STATE IN WHICH INCIDENT OCCURRED
MP_VLV_STA	C	20	0	MILE POST/VALVE STATION
SURV_STA	C	40	0	SURVEY STATION OR LAT. AND LONG.
BLOCK_DESC	C	20	0	GOM: 2 LETTER ABBREV. FOR BLOCK
BLOCK_NUMB	C	10	0	GOM: BLOCK NUMBER
LOC_MEMO	M	10	0	AMPLIFYING INFORMATION ON LOCATION
INC_TYPE	C	10	0	TYPE OF INCIDENT:LEAK,RUPTURE OR OTHER
RUP_LENGTH	C	10	0	LENGTH OF RUPTURE IN FEET
N0_FATAL	N	3	0	NUMBER OF FATALITIES
NO_INJ	N	3	0	NUMBER OF PERSONS INJURED
AMT_DAMAGE	N	8	0	ESTIMATED PROPERTY DAMAGE
HRSTO_SAFE	N	4	0	EST. TIME UNTIL AREA MADE SAFE
DT_PHON_RP	D	8	0	DATE OF TELEPHONIC REPORT
INC_PRESS	N	4	0	PRESS. AT POINT AND TIME OF INCIDENT(PSIG)
MAOP	N	4	0	MAX. ALLOWABLE OPERATING PRESSURE(PSIG)
TEST_PRESS	N	4	0	TEST PRESS. USED TO ESTABLISH MAOP(PSIG)
CFR	L	1	0	LOGICAL: MAOP ESTABLISHED BY 49 CFR 192.619
INC_TIME	C	4	0	TIME OF INCIDENT
INC_DATE	D	8	0	DATE OF INCIDENT
AP_CAUSE	C	20	0	APPARENT CAUSE OF INCIDENT
PRODUCT	C	10	0	PRODUCT TRANSPORTED, E.G. GAS
SYS_TYPE	C	30	0	SYSTEM TYPE: GATHERING, TRANSMISSION
SYS_PART	C	30	0	PART OF SYSTEM: PIPELINE,METER,ETC.
PLINE_PART	C	40	0	SPECIFIC PART FAILED:WELD,VALVE,FITTING,ETC.
PLINE_MATL	C	10	0	PIPELINE MATERIAL
PIPE_SIZE	N	2	0	NOMINAL DIAMETER OF PIPELINE
PIPE_WALL	N	4	0	WALL THICKNESSX10^4 INCHES
PIPE_SPEC	C	20	0	PIPE SPECIFICATION AND SMYS
PIPE_SEAM	C	20	0	SEAM TYPE
PART_AGE	N	2	0	AGE OF PART FAILED
PIPE_AGE	N	2	0	AGE OF PIPELINE
PIPE_MANUF	C	20	0	PIPE MANUFACTURER
MATL_MEMO	M	10	0	AMPLIFYING INFORMATION ON PART FAILED
PREPARER	C	20	0	OPERATOR REPRESENTATIVE
PREP_PHON	C	12	0	OPERATOR REPRESENTATIVE PHONE NUMBER

Continued on next page.

Organization of **GASLIST.DBF** continued:

FIELD	**TYPE**	**WIDTH**	**DEC**	**DESCRIPTION**
CORR_LOC	C	10	0	LOCATION OF CORROSION: INTERNAL, EXTERNAL
CORR_VIS	C	25	0	VISUAL DESCRIPTION OF CORROSION
CORR_CAUSE	C	20	0	CAUSE OF CORROSION
COATED	L	1	0	LOGICAL: WAS PIPELINE COATED?
CATHODIC	L	1	0	LOGICAL:WAS PART CATHODICALLY PROTECTED?
CATH_DATE	D	8	0	YEAR CATH. PROTECTION STARTED (01/01/YEAR)
CORR_MEMO	M	10	0	AMPLIFYING INFO ON CORROSION
DAM_CAUSE	C	30	0	CAUSE OF DAMAGE BY OUTSIDE FORCES
DAM_MEMO	M	10	0	AMPLIFYING INFO ON DAMAGE
CONST_CAUS	C	50	0	CAUSE OF CONSTRUCTION OR MATERIAL DEFECT
CONST_MEMO	M	10	0	AMPLIFYING INFO ON CONST OR MATL DEFECT
OTHER_CAUS	C	50	0	OTHER CAUSE DESCRIPTION
OTHER_MEMO		10	0	AMPLIFYING INFORMATION ON OTHER CAUSE

The database "**LIQLIST.DBF**" is organized as follows:

FIELD	TYPE	WIDTH	DEC	DESCRIPTION
DOT_INFO	L	1	0	DESCRIBES SOURCE IN MASTER DATABASE
OP_ID_NO	C	5	0	OPERATOR IDENTIFICATION NUMBER
OP_NAME	C	40	0	OPERATOR NAME
OP_STREET	C	40	0	OPERATOR ADDRESS
OP_CITY	C	20	0	OPERATOR CITY
OP_STATE	C	2	0	OPERATOR STATE
OP_ZIP	C	5	0	OPERATOR ZIP CODE
INTERSTATE	L	1	0	LOGICAL: INTERSTATE PIPELINE?
INC_DATE	D	8	0	DATE OF INCIDENT
INC_TIME	C	4	0	TIME OF INCIDENT
BLOCK_DESC	C	20	0	GOM: 2 LETTER ABBREV. FOR BLOCK
BLOCK_NUMB	C	10	0	GOM: BLOCK NUMBER
SURV_STA	C	4	0	SURVEY STA OF LAT AND LONG
FEDERAL	L	1	0	LOGICAL: FEDERAL JURISDICTION?
LOC_MEMO	M	10	0	AMPLIFYING INFORMATION ON LOCATION
SYS_PART	C	30	0	PART OF SYSTEM INVOLVED: LINEPIPE, ETC.
PLINE_PART	C	40	0	SPECIFIC PART FAILED:VALVE,WELD,ETC.
PART_AGE	N	2	0	AGE OF PART FAILED
PIPE_AGE	N	2	0	AGE OF PIPELINE
AP_CAUSE	C	20	0	APPARENT CAUSE OF INCIDENT
NO_FATAL	N	3	0	NUMBER OF FATALITIES
NO_INJ	N	3	0	NUMBER OF PERSONS INJURED
AMT_DAMAGE	N	8	0	ESTIMATED PROPERTY DAMAGE
PRODUCT	C	10	0	PRODUCT TRANSPORTED
CLASSIFICA	C	10	0	CLASSIFICATION OF COMMODITY SPILLED
POL_BBLS	N	7	1	POLLUTION IN BARRELS
EXPLOSION	L	1	0	LOGICAL: WAS THERE AN EXPLOSION?
FIRE	L	1	0	LOGICAL: WAS THERE A FIRE?
PIPE_SIZE	N	2	0	NOMINAL DIAMETER OF PIPELINE
PIPE_WALL	N	4	0	WALL THICKNES X 10^4 INCHES
PIPE_SPEC	C	20	0	PIPE SPECIFICATION AND SMYS
JOINT_TYPE	C	10	0	TYPE OF PIPE JOINTS USED
MAOP	N	4	0	MAX. ALLOWABLE OPERATING PRESSURE(PSIG)
INC_PRESS	N	4	0	PRESS. AT POINT AND TIME OF INCIDENT(PSIG)
TEST_PRESS	N	4	0	TEST PRESS. USED TO ESTABLISH MAOP (PSIG)
CORR_LOC	C	10	0	LOCATION OF CORROSION: INT. OR EXTERNAL
COATED	L	1	0	LOGICAL: WAS THE PIPELINE COATED?
CATHODIC	L	1	0	LOGICAL: WAS CATHODIC PROTECTION USED?
CORR_CAUSE	C	20	0	CAUSE OF CORROSION
CORR_MEMO	M	10	0	AMPLIFYING INFO ON CORROSION
DAM_CAUSE	C	30	0	CAUSE OF DAMAGE BY EXTERNAL FORCES
DAM_MEMO	M	10	0	AMPLIFYING INFO ON CAUSE OF DAMAGE
DETECTION	C	10	0	METHOD BY WHICH LEAK WAS DETECTED
PREPARER	C	20	0	OPERATOR REPRESENTATIVE
PREP_PHONE	C	12	0	OPERATOR REPRESENTATIVE PHONE NUMBER

The database "**RMMSDATA.DBF**" is organized as follows:

FIELD	**TYPE**	**WIDTH**	**DEC**	**DESCRIPTION**
MMS_INFO	L	1	0	DESCRIBES SOURCE IN MASTER DATABASE
INC_DATE	D	8	0	DATE OF INCIDENT
POL_BBLS	N	8	1	POLLUTION IN BARRELS
OP_NAME	C	20	0	NAME OF OPERATOR
PIPE_SIZE	N	2	0	NOMINAL DIAMETER OF PIPELINE
SERVICE	C	10	0	SERVICE CLASSIFICATION PER MMS INVENTORY
BLOCK_DESC	C	2	0	GOM: 2 LETTER ABBREV. FOR BLOCK
BLOCK_NUMB	C	3	0	GOM: BLOCK NUMBER
PLATFORM	C	3	0	PLATFORM DESIGNATION (IF ON PLATFORM)
CAUSE1	C	10	0	SHORT DESCRIPTION OF PRIMARY CAUSE
CAUSE2	C	10	0	SHORT DESCRIPTION OF SECONDARY CAUSE
SEG_NUMB	N	7	0	MMS SEGMENT NUMBER
LENGTH	N	6	0	LENGTH OF PIPE SEGMENT PER MMS INVENTORY
CONST_DATE	D	8	0	DATE PIPELINE CONSTRUCTED
BURIED	C	1	0	BURIED?:YES(Y),NO(N),SURFACE(S)
PART_DAM	C	10	0	PART OF SYSTEM DAMAGED

The database "**NRCINFO.DBF**" is organized as follows:

FIELD	TYPE	WIDTH	DEC	DESCRIPTION
NRC_INFO	L	1	0	DESCRIBES SOURCE IN MASTER DATABASE
OP_NAME	C	20	0	NAME OF OPERATOR
BLOCK_DESC	C	2	0	GOM: 2 LETTER ABBREV. FOR BLOCK
BLOCK_NUMB	C	3	0	GOM: BLOCK NUMBER
PLATFORM	C	3	0	PLATFORM DESIGNATION (IF ON PLATFORM)
NO_FATAL	N	3	0	NUMBER OF FATALITIES
NO_INJ	N	3	0	NUMBER OF PERSONS INJURED
AMT_DAMAGE	N	8	0	ESTIMATED PROPERTY DAMAGE
EXPLOSION	L	1	0	LOGICAL: WAS THERE AN EXPLOSION?
FIRE	L	1	0	LOGICAL: WAS THERE A FIRE?
INC_TIME	C	4	0	TIME OF INCIDENT
INC_DATE	D	8	0	DATE OF INCIDENT
SERVICE	C	10	0	TYPE OF SERVICE (PRODUCT)
POL_BBLS	N	8	1	POLLUTION IN BARRELS
PART_DAM	C	10	0	PART OF SYSTEM DAMAGED
PIPE_SIZE	N	2	0	NOMINAL DIAMETER OF PIPELINE
CAUSE1	C	10	0	SHORT DESCRIPTION OF PRIMARY CAUSE
CAUSE2	C	10	0	SHORT DESCRIPTION OF SECONDARY CAUSE
DETECTION	C	10	0	METHOD BY WHICH LEAK WAS DETECTED
MAX_DEPTH	N	4	0	MAXIMUM DEPTH OF PIPELINE SEGMENT

APPENDIX C: KEY TO ABBREVIATIONS IN DATABASE

Causes of failures: Data Fields CAUSE1 and CAUSE2:

CATEGORY	ABBREVIATION	DESCRIPTION
UNKNOWN	UNK	CAUSE STATED AS "UNKNOWN" ON REPORT
NOT GIVEN	NOT GIV	CAUSE STATED AS "NOT GIVEN" ON REPORT
EXTERNAL FORCES		
ANCHORS	ANCHOR	DAMAGE BY ANCHOR FROM ANY VESSEL
	WB ANCHOR	DAMAGE BY ANCHOR KNOWN TO BE FROM A WORKBOAT
TRAWLS/NETS	TRAWL	(ALSO NET)-DAMAGE BY FISHING TRAWL OR NET
	BOAT	
WORKBOATS	JACKUPRIG	(ALSO JACKUPBARG/LIFT BOAT/ FIELDBOAT) DAMAGE FROM ONE OF THESE VESSELS
	DRAGGEDOBJ	(ALSO FOREIGN OBJECT)-UNKNOWN OBJECT ON SEAFLOOR
	JETBARGE	(ALSO JETSLED)-DAMAGE BY JETSLED WORKING ON NEARBY PIPELINE
	DREDGE	DAMAGE BY DREDGE
GENERAL	EXTFORCE	CAUSE STATED AS "EXTERNAL FORCE" W/ NO FURTHER DESCRIPTION
PIPELINE RUBBING	ABRASION	DAMAGE FROM PIPELINE RUBBING AGAINST OBJECT
CONSTRUCTION	CONST DAM	DAMAGE FROM CONSTRUCTION (NO FURTHER EXPLANATION GIVEN)
2ND PARTY VESSELS	FREIGHTER	DAMAGE BY FREIGHTER STRIKING PLATFORM
	VGROUNDING	DAMAGE BY VESSEL "GROUNDING" ON PIPELINE
HYDRODYNAMIC	WAVES	(ALSO WIND AND WAVES) DAMAGE BY WIND AND WAVES
	STORM	DAMAGE DURING STORM
	HURRICANE	DAMAGE DURING HURRICANE
	FATIGUE	FAILURE DUE TO FATIGUE
GEOTECHNICAL	MUDSLIDE	DAMAGE BY MUDSLIDE
CORROSION	CORROSION	CORROSION NOT SPECIFIED AS INTERNAL OR EXTERNAL
	EXTCOR	EXTERNAL CORROSION
	INTCOR	INTERNAL CORROSION
	EROSION	EROSION CORROSION

Causes of failures: Data Fields CAUSE1 and CAUSE2(continued):

CATEGORY	ABBREVIATION	DESCRIPTION
MATERIAL		
	GASKET	MISALIGNED OR FAILED GASKET
	WELDFAIL	FAILURE OF WELD
	VALVELEAK	LEAK AT VALVE
	CLAMPLEAK	LEAK AT CLAMP OR PREVIOUS REPAIR
	FITTINGLK	LEAK AT UNSPECIFIED FITTING
	SEAMLEAK	LEAK AT PIPE SEAM
	JOINTLEAK	LEAK AT UNSPECIFIED "JOINT"
	FLANGELEAK	LEAK AT PIPELINE FLANGE
MAINTENANCE/ OPERATION		
	STUCK PIG	(ALSO PIGGING)PIG STUCK OR LEAK DEVELOPED DURING PIGGING
	PARAFFIN	PARAFFIN PLUG IN PIPELINE
	HUMAN	HUMAN OPERATING ERROR

Block Descriptions:

ABBREVIATION	BLOCK DESCRIPTION
BA	BRAZOS
BM	BAY MARCHAND
BS	BRETON SOUND
CA	CHANDELEUR
EB	EWING BANK
EC	EAST CAMERON
EI	EUGENE ISLAND
EW	EWING BANK
GA	GALVESTON
GB	GARDEN BANKS
GC	GREEN CANYON
GI	GRAND ISLAND
HI	HIGH ISLAND
HA	HIGH ISLAND ADDITION
MC	MISSISSIPPI CANYON
MI	MATAGORDA ISLAND
MO	MOBILE
MP	MAIN PASS
MU	MUSTANG ISLAND
PL	SOUTH PELTO
SA	SABINE PASS
SM	SOUTH MARSH ISLAND
SP	SOUTH PASS
SS	SHIP SHOAL
ST	SOUTH TIMBALIER
VK	VIOSCA KNOLL
VR	VERMILLION
WC	WEST CAMERON
WD	WEST DELTA

Appendix D - Points of Contact for Further Study:

American Gas Association
1515 Wilson Blvd
Arlington, VA
(703)841-8400

American Petroleum Institute
2101 L. Street, N.W.
Washington, D.C. 20036
(202)457-7000

API Pipeline Committee-Des & Const
Chairman: John Moore, Exxon (713)656-5829
Vice Chairman: Andy Dakis, Chevron (415)842-6961

API Pipeline Committee-Op & Maint
Chairman: Larry Clynch, Conoco (405)767-6352

American Society of Civil Engineers
290 Temple Street
Long Beach, CA 90803

American Society of Mechanical Engineers
United Engineering Center
345 East 47 Street
New York, NY 10017
(212)644-7722

American Welding Society
2501 NW Seventh Street
Miami, FL 33125
(305)642-7090

Army Corps of Engineers

Association of Oil Pipelines
1725 K Street, Suite 1208
Washington, DC 20006
(202)331-8228

California Coastal Commission
(916)543-8555(Sacremento)
(415)904-5200(SF)

California Dept of Conservation
State of California
Department of Conservation
Division of Oil and Gas
1416 Ninth Street, Room 1310
Sacremento, CA 95814
(916)445-9686

California Dept of Conservation(Field Offices)
- -District One(Long Beach)-(213)590-5311
- -District Two(Ventura)-(805)654-4761
- -District Three(Santa Maria)-(805)937-7246

California Dept of Transportation
(916)445-2201

California Seismics Safety Council
(916)322-4917

California State Fire Marshall
(818)937-7246

California State Lands Commission
245 West Broadway, Suite 425
Long Beach, CA 90802-4471
(213)590-5229

Coast Guard

CONCAWE

Concerned Shrimpers of America

Cutter Information
Arlington Mass-
(617)648-8700

Dept of Commerce
National Ocean Service

Dept of Energy
National Petroleum Council
(202)393-6100

Federal Energy Regulatory Commission
(202)586-5000

Dept of Transportation
Office of Pipeline Safety
400 Seventh St SW
Washington, DC
(202)366-4583

Det Norske Veritas

GAO
(202)275-6241

Golups
(800)666-4430
(617)491-5100

Institute of French Petroleum
    Bureau Veritos

Louisiana Office of Conservation
La. Dept of Natural Resources
P.O. Box 94275
Baton Rouge, LA 70804-9725
(504)342-5505

Louisiana Shrimp Association

Minerals Management Service
Department of Interior
Minerals Management Service
Washington, DC 20240
Charles Smith (Herndon,VA)-(703)787-1559
Alex Alvarado (Metarie)-(504)736-2547

National Response Center
2100 Second St SW
Room 2611
Wash,DC 20593

National Technical Information Service
(800)553-NTIS

National Transportation Safety Board
Charles Batten, Chief,(202)382-0760

Offshore Magazine

Oil and Gas Journal
(918)835-3161

Oil Pipeline Research Institute

Petroleum Information Service
University of Tulsa
Tulsa, OK
Houston-(713)961-5660

Pipeline and Gas Journal

Pipeline and Utilities Construction
(713)622-0676

Pipeline Digest
(713)468-2626

Southwest Research Institute
San Antonio, TX
(512)522-5086

Texas Railroad Commission
(512)463-7058

Texas Shrimp Association

TransCo Energy (TransWestern)
(713)439-2000

Transportation Research Board

World Information Systems
PO Box 535
Cambridge, MA 02238
(619)491-5100

World Offshore Accident Database

Thesis
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failures.